Transactions of American Society for Steel Treating

Published Monthly | Cleveland, May, 1921 | Ten Dollars a Year

Vol. I | *Entered as second-class matter Feb. 7, 1921 at the post-office at Cleveland, Ohio, under the Act of March 3, 1879* | No. 8

SPECIAL FEATURES

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4600 Prospect Avenue

TRANSACTIONS

of the

American Society for Steel Treating

Vol. 1 Cleveland, May, 1921 No. 8

AN EFFORT WELL DIRECTED

That the American Society for Steel Treating is spreading its influence beyond the limits of its membership rolls has been demonstrated clearly by successful conclusion of an instructional course recently completed in co-operation with two of Chicago's leading technical schools. Feeling the need for greater education along heat treating and forging subjects, the Chicago Chapter, under the direction of its chairman and Educational Committee, approached the Armour Institute of Technology and Lewis Institute regarding the advisability of conducting a course of evening classes. Both schools approved of the suggestion but because of the lack of experienced instructional material, were unable to conduct the work without assistance. The Chicago Chapter, however, removed this stumbling block by offering instructional assistance recruited from chapter members experienced in various phases of the work. Thus through the co-operation of two instructors, one in each school, and the volunteers from the chapter, a course of study was mapped out for a period of 20 evenings. This course has just been completed with highly gratifying results.

Elsewhere in this issue is contained a detailed account of this educational course together with an outline of the subjects treated in lectures and experiments. Briefly the subjects considered were: Pyrometry, metallography, forging, annealing, alloy steels, hardening and tempering tool steels, and case hardening.

The success of the Chicago Chapter's experiment should encourage other chapters of the Society to initiate and conduct similar courses of instruction. Possibly needs for such education will vary according to the number, size and nature of steel treating industries located in certain localities but modifications can be made to suit local conditions. Because of the remarkable growth of steel treating in recent years and the introduction of alloy steels requiring accurate and varying treatments, the universities, colleges and schools have been unable to provide adequate instruction. Moreover, the men who have been highly trained in metallurgical lines have found places in executive or laboratory positions and have not been able to pass their knowledge down to the practical steel treater.

A significant feature of the Chicago course was that the classes were composed of hardening room workers and students who were eager for training along practical lines. To the average shop worker such training offers exceptional opportunity for advancement and as such opportunities are extended, without doubt, they will enroll in increasing numbers. It

PROFESSOR ALBERT SAUVEUR

is hoped that other chapters of the Society will see fit to encourage the starting of educaional courses and will thus aid in the advancement of the art by passing down the line information of an accurate and reliable character.

PROFESSOR ALBERT SAUVEUR ELECTED HONORARY MEMBER

On Jan. 31 a petition was presented to the Board of Directors containing the nomination of Professor Albert Sauveur, professor of metallurgy and metallography at Harvard University, for Honorary Membership in the American Society for Steel Treating.

This nomination received the unanimous vote of the Board, and consequently Professor Sauveur was elected as the third Honorary Member of the Society.

When Professor Sauveur was in Cleveland on April 22, the certificate of Honorary Membership was presented to him by the National Secretary, W. H. Eisenman acting for the National President, Lieut. Col. A. E. White who was unable to attend.

In presenting the Honorary Membership, Mr. Eisenman gave a brief statement of the life work of Professor Sauveur as follows:

"Albert Sauveur was born in Louvain, Belgium in 1863 of French parentage. He received his early education at the School of Mines in Liege 1881-1886. He was granted an S. B. in Mining and Metallurgy by the Massachusetts Institute of Technology in 1889, and served as chemist and metallurgist for various steel companies including the Pennsylvania Steel Co. and the South Chicago Works of the Illinois Steel Co. from 1889-1897. While at Chicago he began his pioneer work in metallographic research in connection with some heat treatment experiments and published the results in the Transactions of the American Institute of Mining and Metallurgical Engineers, the paper being read at the Chicago meeting in 1893.

"His first microscope was a so-called professional instrument and with an ordinary barrel for a work bench, using sun light as a source of illumination he created that early work which was destined to have such a wide influence on the manufacture and heat treatment of steel in America.

"In 1896 he wrote another paper for the American Institute of Mining and Metallurgical Engineers on the Microstructure of Steel and the Current Theories of Hardening, which summarized to that date, the ideas of various metallurgists regarding the reason for the hardening of steel. This provoked so large a discussion both in America and abroad that it marked an epoch in the history of heat treatment. It clarified the ideas regarding this phenomenon to a remarkable extent.

"In 1899 he was called to Harvard University as instructor and was assistant professor in metallurgy and metallography from 1900-1905. Since then he has been professor of metallurgy at Harvard and at the same time has been very active in committee work for the various technical societies.

"He edited *The Metallographist,* 1898-1903 and *The Iron and Steel Magazine* 1903-1906, and was lecturer on metallography from 1898-1903 at the Massachusetts Institute of Technology. He is an Officer d'Academie and in 1913 was awarded the Elliott Cresson gold medal by the Franklin Institute of Philadelphia. He is a Fellow of the American Academy of

Arts and Sciences and a member of the following societies: American Philosophical Society, National Institute of Social Sciences, American Association for the Advancement of Science, American Institute of Mining and Metallurgical Engineers, holding the office of vice president from 1910-1912; and chairman of the Iron and Steel Committee 1913-1915. He is also a member of the Iron and Steel Institute of Great Britain and of the American Iron and Steel Institute and has contributed valuable papers to the transactions of both of these societies. He was president of the John Fritz Medal Board of Awards in 1916-17. In 1917-19 he was metallurgist of the American Aviation Commission in France and later director of Research for the Metallurgical Division, Air Service, A. E. F. stationed in Paris, where he and his family remained during the German air raids and the long distance bombardment by the Big Berthas.

"Professor Sauveur's best known work is a book entitled 'The Metallography and Heat Treatment of Iron and Steel' but he has written many other articles on metallographic subjects and during the war published two papers entitled 'Germany and the European War' (1915); and 'Germany's Holy War'."

INDIANAPOLIS CONVENTION PLANS PROGRESSING

Wonderful progress is being made for the Convention to be held in Indianapolis Sept. 19 to 24, 1921. Professor H. L. Campbell, of the University of Michigan has been appointed chairman of the Meetings and Papers Committee, and has already set the machinery in motion for securing a set of papers of very high standard, most interesting and entertaining. The suggested topics for papers is printed elsewhere in this issue of the TRANSACTIONS.

The Board of Directors at its recent meeting authorized the awarding of a gold medal to the best paper prepared for the Indianapolis Convention, and approved also the awarding of a silver medal for the second best paper presented at that time. The policy with reference to medals to be followed in the future, is the presenting of these medals for the best papers presented during the year, including, of course, those presented at the Convention.

The Exhibition is making very rapid progress and requests for space have been remarkable. More reservations have been received at this time than were received up until June 15 for the 1920 Exhibition in Philadelphia. The Indianapolis chapter held a meeting recently in which it appointed chairmen of various committees to make preparation for the entertainment of the visitors and their wives in Indianapolis. They are sparing no effort or money to make the Convention a decided success from the standpoint of local entertainment. The various chairmen have organized their committees and have been in constant communication with the National office. It is a foregone conclusion that no detail will be left incomplete which will add to the pleasure and enjoyment of the visiting members.

A list of the hotels at which reservations may be made will be published in the next issue of the TRANSACTIONS.

RESIGNATION OF FIRST VICE PRESIDENT T. E. BARKER


T. E. Barker

T. E. Barker has presented his resignation as first vice-president of the American Society of Steel Treating, to take effect Sept. 19, the first day of the Annual Convention and Exhibition to be held in Indianapolis. Mr. Barker's resignation was presented to the Board of Directors at its meeting in the executive offices in Cleveland on April 9 and was accepted with expressions of deep regret by the entire board.

For fourteen years Mr. Barker was production manager of the Miehle Printing Press Co., Chicago, and withdraws from that firm to become associated with the Denver Rock Drill & Mfg. Co., Denver, Col., on May 1.

Mr. Barker served as the first chairman of the Chicago section of the Steel Treating Research Society and thus became interested in the work and activities which have led to the development of the present organization. When the American Steel Treaters Society was organized he served one year as acting president, and in September, 1919, was elected national president. During the following year the amalgamation of the Steel Treating Research Society and the American Steel Treaters Society progressed to a successful completion and the Nominating Committee of the amalgamated society proposed Mr. Barker as first vice president to serve two years, and he was elected at the meeting in Philadelphia in September, 1920.

During the time of Mr. Barker's connection with the Society, he has always taken a most unselfish and unbiased attitude, and has always considered only the best interests of the organization. The Board of Directors will feel particularly the loss of Mr. Barker from its councils, yet it sends with him its best wishes for his continued success and prosperity in his new location.

THINGS TO BE DONE

By Arthur W. F. Green*

In comparatively few years the steel treater has risen to an indispensable position in the steel industry and its allied manufactures. While many steel treaters are college men, a great number has been graduated from the great school of experience. The rise of the steel treater has in many cases been from that of common laborer to skilled worker. He is today an artisan. The evolution of the automobile can be traced in no small extent to his untiring efforts coupled with systematic chemical and physical research. Therefore, it is logical to say and think that things have been done, but, there are many things which are as yet only partly done or wholly untouched. If the steel treater is to progress and bring his profession to even higher fame than that already reached, he must attack the partly done and untouched problems and offer solutions in clear, concise, systematic and scientific terms.

* Chief of laboratory, John Illingsworth Steel Co., Philadelphia.

A Photograph of the National Board of Directors at Its Meeting in Cleveland, April 9. Seated from Left to Right Are: Lt. Col. A. E. White, President; T. D. Lynch, Second Vice President; Frank P. Fahy; T. E. Barker, First Vice President; W. S. Bidle, Treasurer; H. J. Stagg; W. H. Eisenman, Secretary; W. C. Peterson; and E. J. Janitzky

Within a very few months the one Society will be holding its Third Annual Convention and Exhibition in Indianapolis. The Convention offers to those who will, a chance to discourse on topics of interest to the membership at large. It is a time and a place where big things count. It is not to be used as time and a place to grind one's ax or otherwise to make a personal show. Drawing upon experience as chairman of the Meetings and Papers Committee last year, the author urges the necessity of preparing readable papers, and papers that substantiate by carefully conducted investigation the points advanced. I wish, therefore, to sow a few seeds in your minds, which will grow into big things and be ripe for the harvest at the time of the Convention. The topics to be mentioned are in need of solution, and to offer a solution which will satisfy, means that intelligent work must be done through mediums of justifiable and reliable research and investigation.

Some time ago I attended a meeting of several typical steel treaters. In the course of the general conversation the question of fiberizing arose. The question came up as to what particular properties the treatment gave to steel, and whether or not there were not other treatments already named and in wide use which imparted the same properties. After much discussion, all present realized that none could give a workable definition for fiberizing. They concluded that the word fiberizing, as applied to heat treatment of steel, was a more or less doubtful term. It is quite possible that all of you could readily define the word and treatment it stands for without one moment's hesitation, but there are many of your co-workers who are not able to do so. We should have some investigation of the subject, supported by microscopic and physical analysis which will substantiate for all time the claims that fiberizing is a definite kind of heat treatment and produces certain results which no other treatment process will do.

If I were desirous of actually starting an argument, I would give you a definition of the process of normalization. I have never read or heard a good definition of it. Only recently, I heard the term used in a paper which was written by one of the greatest exponents of the heat treating art, and I also heard the writer refuse to make his definition general or, in other words, to have an application outside of the particular problem being discussed. What does constitute normalizing? You have your ideas about the matter and I have mine. Who is right? In these days of definitions and laws no term should be allowed to remain in a hazy form if the profession with which we are associated is to progress. We must get down to facts. The correct treatment which is to constitute normalizing must be defined. We must have a common understanding of it and the definition must be backed up by careful analytical work and reasoning. When a normalizing treatment is to be used it must be one particular phase of the series of heat treatment and must not infringe upon a treatment which is already existent.

The decarburization of material in furnaces has usually been accepted as a necessary evil. If any of you attended the Convention last year in Philadelphia, you will recall a discussion that took place in which even the correct word to use was considered. That discussion was printed in full in the March issue of TRANSACTIONS, but I assure you that the hearing was much more interesting than the reading. However, nothing was gained. The factors which go into causing decarburization were not mentioned and the whole matter was left suspended in the air. If research has been done

which is of a beneficial turn it should be placed at the disposal of the steel treater. There must no longer be a secret treatment for this and that. The art is held back just as long as those who profess it do not share their experiences and knowledge. The Convention is the place to air opinions and processes. Opinion especially carries weight because it will always bring an argument. If decarburization is due to certain feature of furnace gases of certain fuels then something is there to be worked on. We must find out.

The oxidation of materials in furnaces has long been a serious problem for the steel treater. Many papers have been written offering solutions of the difficulty and many things which will alleviate the condition, have been produced by minds that are constructive. But, there is much to be done. Everyone of you has read the article by O. Lellep in the March issue of TRANSACTIONS and I believe you will agree with him when he states "the incompleteness and incorrectness of the practical language which often uses the terms reducing flame and oxidizing flame." Mr. Lellep goes a long way toward clearing up some of the cobwebs around the problem, but more must be done if the "incompleteness and incorrectness" is to be changed to "complete and correct practical language." In the March 17 issue of the *Iron Age* an article appears under the caption "Application of Gas Fuel to Forging" and a discussion is included on the subject of oxidation. It is treated of course from a standpoint of fuel application. There are, therefore, efforts being made to arrive at definite conclusions in the matter, but it is my belief that the steel treater has within his grasp the correct answer to the problem if he will get down to work. The Convention is the time to discuss such important problems and the TRANSACTIONS will act as the medium to send them broadcast.

I have by no means covered the subject of things to be done. Some time ago, I was in conversation with the chief research engineer of the United States Army Ordnance Department and he told me of a problem that must be faced. It has been possible to heat treat the armor plate for tanks so that it will resist a 75-millimeter shell but when it is in that condition it will not resist machine gun bullets. If treated to resist the machine gun bullets the shells easily shatter the plates. In his opinion it is a matter for the steel treater to fathom as various conditions have shown that the armor plate used has a great deal in its favor. I only tell you this to say that the problems of the steel treater are indeed varied. He must keep up to the minute in everything connected with the art. He should follow carefully all new developments whether it be in the alloy steels or in the founding of an organization to standardize pyrometers. The steel treater is the exponent of a practically new art. He is going to make that art great in exactly the proportion he gives of himself to its advancement. There are great problems in furnace construction, fuel application, the efficiency of quenching mediums, the use of various salts, and the problem which so often is dodged, efficiency in production, etc.

The Convention is the right place to bring big things for solution. The men who attend may criticize but their criticism is constructive and seldom, if ever, destructive.

There are THINGS TO BE DONE and you are the DOERS.

MANUFACTURE OF STEEL FROM RAW MATERIALS TO FINISHED PRODUCT—REMARKS ON HEAT TREATMENT AND FATIGUE FAILURES

By W. R. Shimer*

(A Paper Presented Before the Springfield Chapter)

Iron ore, limestone and coke are the raw materials used to make pig iron. Of the three large ore bodies located in Cuba, Chile and Cornwall, Pa., and controlled by the Bethlehem Steel Co., the Chilean mine is in some ways the most interesting development. It is located at Tofo, Chile, on top of a mountain which is four miles inland and 2000 feet above sea level. The ore is very rich and pure, containing approximately 68 per cent iron, and is very low in phosphorus and sulphur. The mining operation is an open cut proposition, the ore being picked up by grab buckets and electric shovels and conveyed by an electric tramway from the mines to the coast four miles away. Many million tons of ore are in sight at this mine.

One of the Cuban mines produces a large tonnage of ore containing nickel and chromium. This is reduced in the blast furnace and made into a high grade of pig iron for foundry purposes, containing 2 per cent chromium and 1 per cent nickel. This is called Mayari iron as the ore comes from the Mayari district in Oriente, Cuba. It is an excellent iron for foundry purposes and is used in the manufacture of high grade iron castings such as chilled iron rolls, automobile castings, which include cylinder heads and pistons; chilled car wheels; white iron; heat resisting iron; high test cast iron, etc., by varying the additions of Mayari pig iron to the ordinary pig iron in the cupola.

Iron ore is charged in the blast furnace together with coke and limestone and is reduced to pig iron. An article describing the blast furnace and the method of making pig iron was published in the March issue of TRANSACTIONS. Pig iron, together with certain percentages of steel scrap, a small amount of iron ore and limestone, are charged into the open-hearth furnace for making steel. This discussion of steelmaking will be confined to the open-hearth process as the subject is too broad to include the making of steel by the other processes.

After the material charged into the open-hearth furnace has become liquid, the melter, by means of an iron spoon on a long handle, dips a small amount of metal from the furnace and casts a small test ingot which is fractured and analyzed to guide him in the making of the heat. These tests are taken at intervals from the time the heat is melted until the composition aimed for is obtained, at which time the final additions are made and the heat tapped. The open-hearth melter becomes very expert in judging the carbon content of his bath from the heat test fractures.

Fig. 1, of the accompanying illustrations, shows a number of heat tests taken at various stages of melting, and illustrates the different types of fractures that are obtained during this operation. The percentages written above each fracture indicate the carbon content of the bath as judged by the melter from the appearance of the heat test fracture. The figures written below indicate the actual percentage of carbon as determined by the

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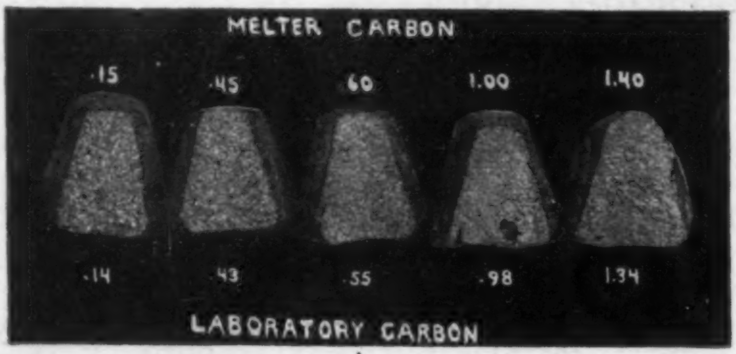

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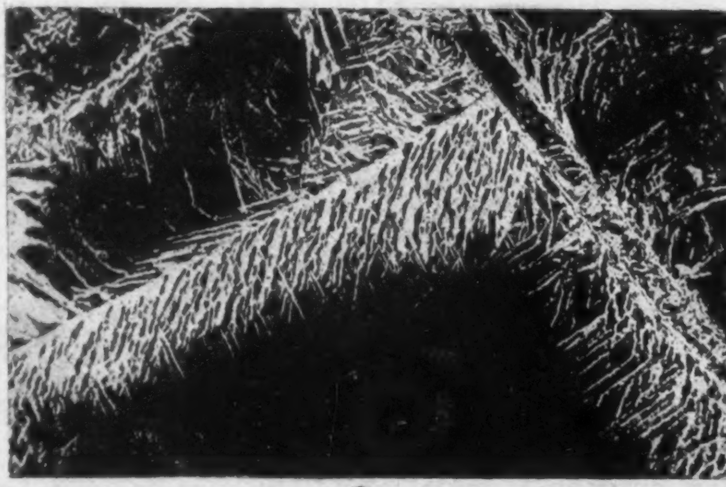

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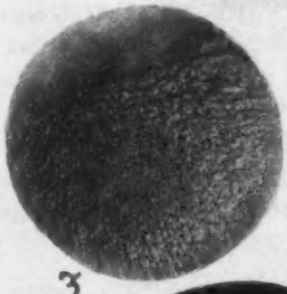

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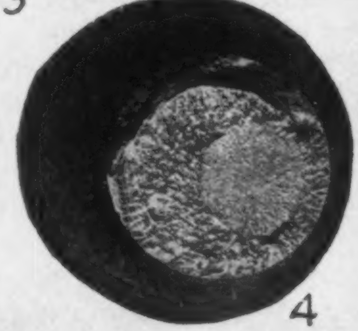

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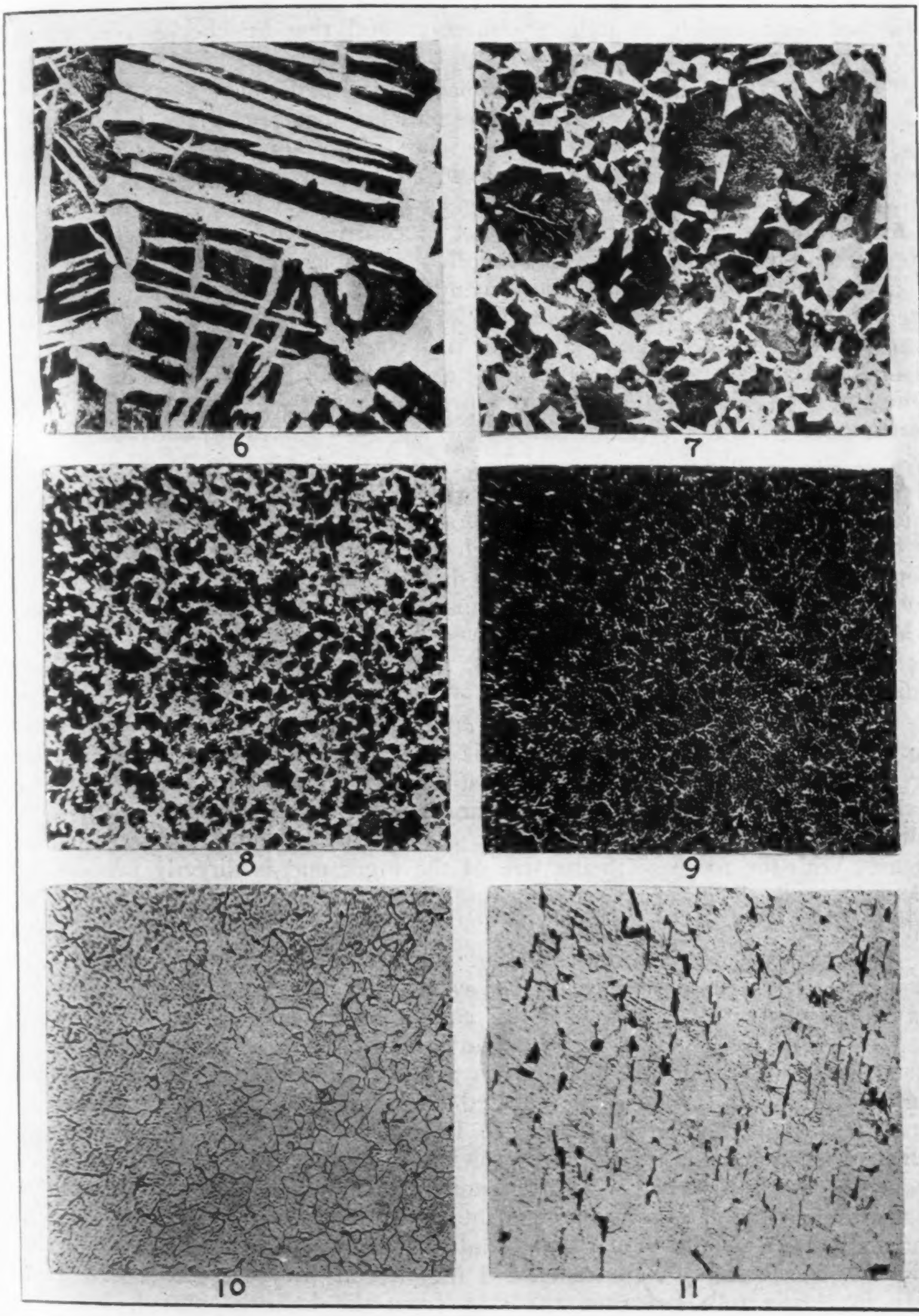
Fig. 1—Heat test fractures. Figures above show melter's estimated carbon content in per cent, figures below give actual carbon content. Fig. 2—Typical microscopic structure of overheated rivet × 100. Fig. 3—Fracture of failed nickel steel drop hammer piston rod. Fig. 4—Fracture of failed rivet set which had been nonuniformly hardened. Fig. 5—Piece from broken steel roll showing fossil fern shape of the progressive fatigue break.



Figs. 6-9—Photomicrographs representing various structural changes from steel ingot to finished forging. Fig. 6—Widmanstatten of ingot indicating slow cooling from high temperature × 100. Fig. 7—Structure of forging as forged × 100. Fig. 8—Structure of forging annealed for machinea-bility × 100. Fig. 9—S ructure of forging after final heat treatment × 100. Figs. 10-11—Photomicrographs of iron containing practically no carbon and steel containing carbon up to 1.05 per cent, showing progressive increase of pearlite and decrease of ferrite. Fig. 10—Iron containing 0.01 per cent carbon × 100. Fig. 11—Iron containing 0.10 per cent carbon × 100. All specimens etched with picric acid.

laboratory. By comparing these percentages it will be seen that the melter becomes quite expert in judging fractures and that he checks very closely with the chemical laboratory.

The metal in the furnace is tapped into a ladle, which is conveyed to the ingot molds, and is cast into these molds usually by the box pouring method. Generally, when the size of ingot is not too large, two ingots are poured at one time through the box which has two openings. One of the advantages of this method of pouring as compared with casting into ingots direct from the ladle is that the steel is cooler going through the box by approximately 100 degrees Fahr. Another advantage is that it permits slower pouring which is important in the manufacture of sound ingots. The ideal method for making ingots would be for steel to solidify the instant it was cast, but since this is impossible the manufacturer of high grade steels attempts to cast the steel into the ingot as slowly as possible and at as low a temperature as possible in order to approach as nearly as practicable the ideal condition.

When the metal in the mold has solidified, the ingots are stripped and charged into furnaces for heating prior to rolling or forging. In the rolling operation the ingot is reduced on a blooming mill to sections approximately 8 x 8 inches or 9 x 9 inches, which are conveyed along a runway to the hot shears where the top and bottom discards are cut away and the blooms cut to the desired length. The blooms are then sent to the chipping beds where the surface defects are removed by use of pneumatic chisels. All defects such as seams, laps and scabs, are removed prior to rolling into the finished product.

As mentioned before, the ideal condition would obtain if steel could be made to solidify instantly. If this were possible, segregation of carbon or any of the other nonferrous constituents in steel would be eliminated. Every effort is made by the steel manufacturer to eliminate as much segregation as possible within the limits that nature permits. Segregation increases with the increase in the size of the ingot and is directly proportional to mass and the rate of solidification, the larger ingots solidifying less rapidly than the smaller ones.

Many steel users seem to be of the opinion that the source of slag in steel is furnace slag or ladle slag which becomes imbedded in the ingot. Careful reasoning will show that this cannot be the case because open-hearth slag is so much lighter in weight than steel that it floats to the top of the metal as readily as a cork bobs up in a bath of water when it is immersed and released. To prove this, repeated experiments were made by taking a small test ingot, not larger than 8 to 10 cubic inches, from a ladle of steel which was almost empty, at the time when both steel and slag were dripping from the nozzle together. Upon examination of this test ingot it was found that although the slag and steel ran into the mold at the same time, the slag had separated to the upper part and the lower part was a sound steel button. These small ingots solidified the instant they were cast and therefore in this very short time the slag from the ladle separated, leaving a steel button which was free from slag. Sections of these steel buttons were polished and examined carefully with a miscroscope but no slag could be found.

Additional evidence that this is not the origin of slag in steel, is that furnace and ladle slag contains lime whereas the socalled slag inclusions in

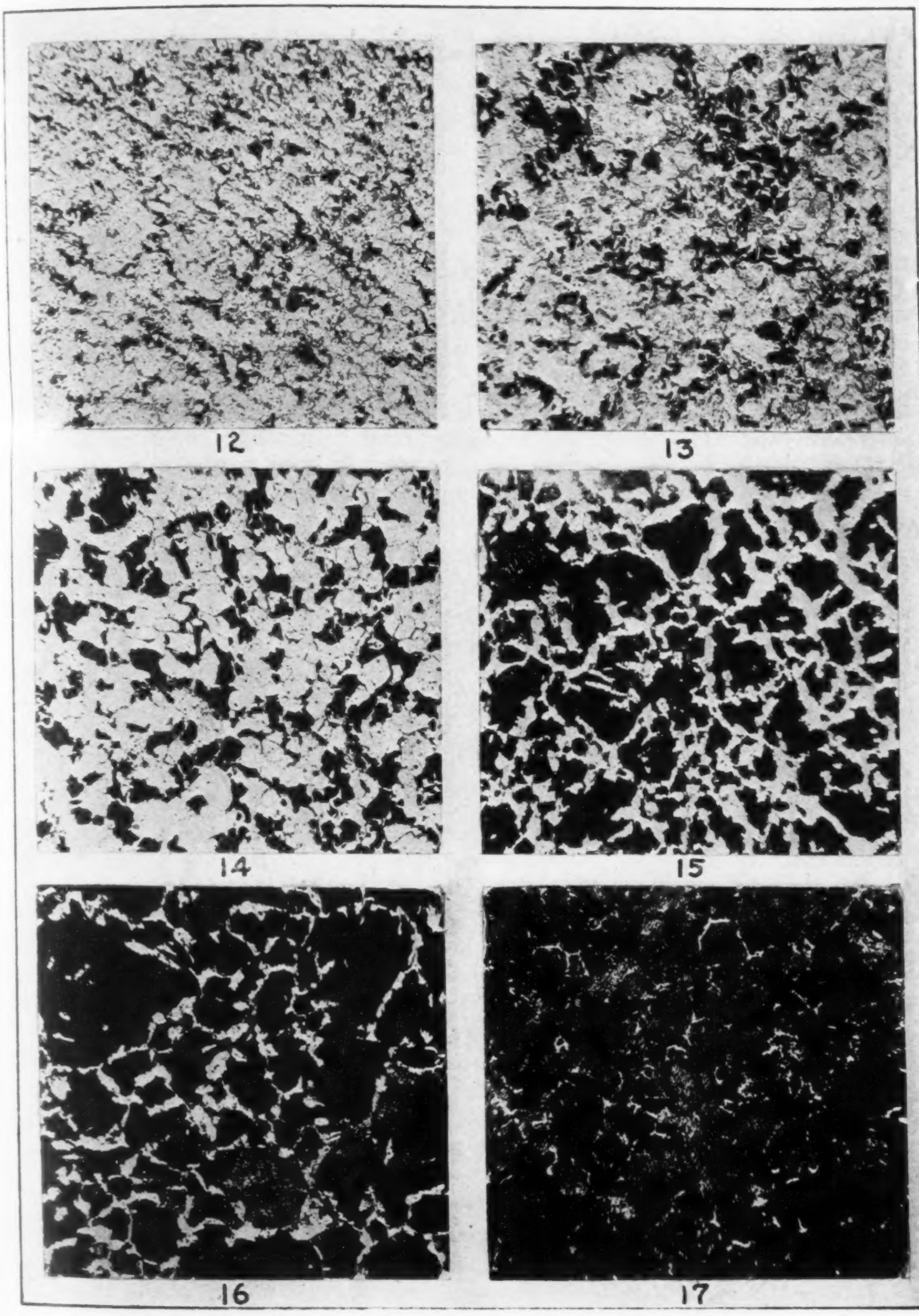


Fig. 12—Iron containing 0.20 per cent carbon × 100. Fig. 13—Steel containing 0.30 per cent carbon × 100. Fig. 14—Steel containing 0.40 per cent carbon × 100. Fig. 15—Steel containing 0.50 per cent carbon × 100. Fig. 16—Steel containing 0.60 per cent carbon × 100. Fig. 17—Steel containing 0.70 per cent carbon × 100. The increase in pearlite and decrease in ferrite is evident as the carbon increases. All specimens etched with picric acid.

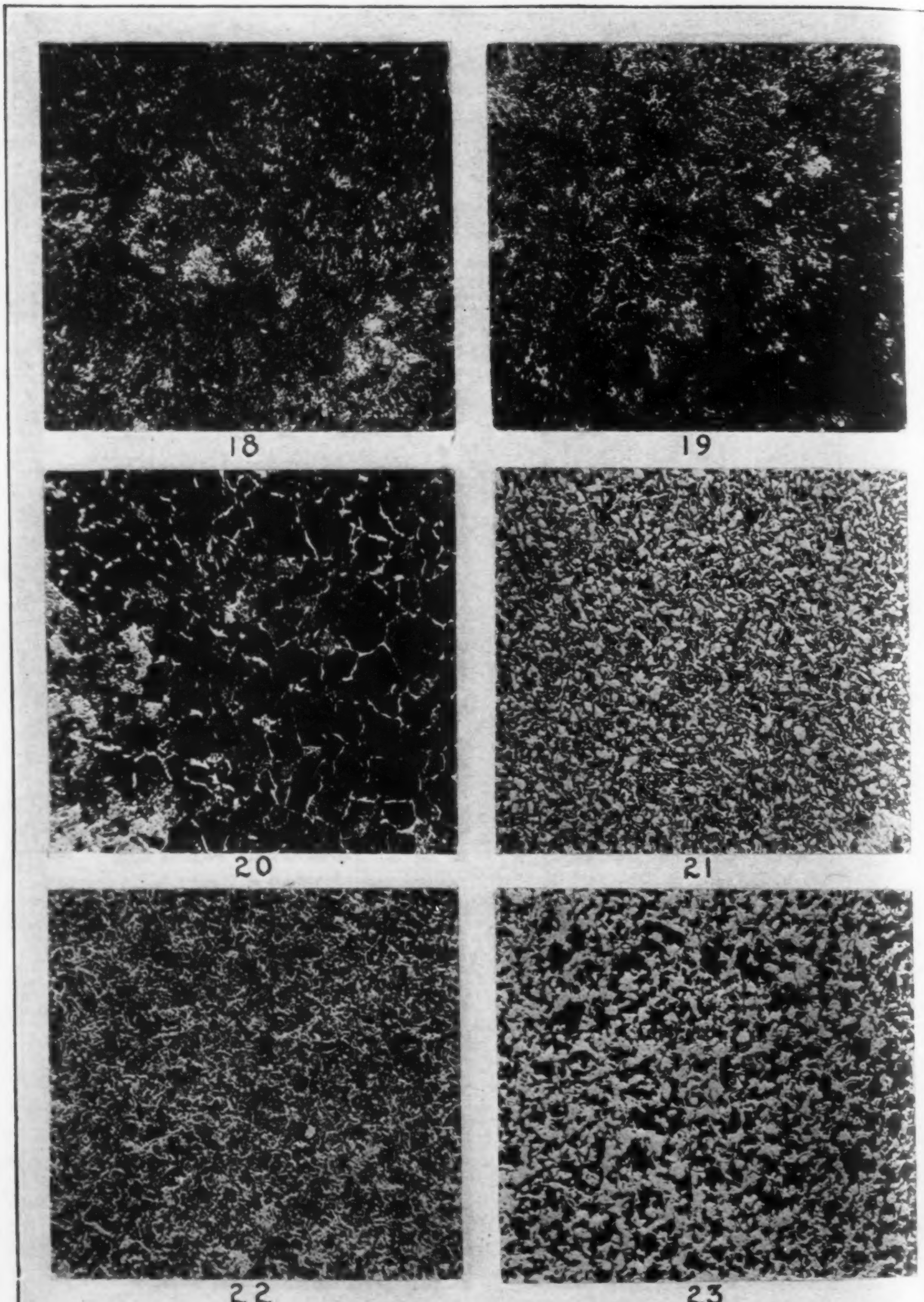


Fig. 18—Steel containing 0.80 per cent carbon × 100. Fig. 19—Steel containing 0.90 per cent carbon × 100. Fig. 20—Steel containing 1.05 per cent carbon × 100. Here again the increase in pearlite and decrease in ferrite is apparent as the carbon increases. All speciments etched with picric acid. Fig. 21—Structure of test bar of 89,000 pounds per square inch tensile strength × 100. Fig. 22—Structure of test bar of 124,000 pounds per square inch tensile strength × 100. Fig. 23—Structure of test bar, Fig. 21, after reannealing with high tensile bar × 100.

steel consist mostly of sulphides and silicates of iron and manganese, and no lime whatever. The nonmetallic inclusions in steel are caused by reactions occurring in the molten metal in the ingot mold prior to solidification. Some of these impurities work to the top of the ingot as long as the top is molten, but after the upper part becomes solidified and while the interior is still molten, the reaction continues and these inclusions are imprisoned, becoming more numerous as the size of the ingot increases, since it requires a longer time for a large mass of metal to solidify.

The above explains briefly the operation necessary to produce steel from raw materials. At this point it is of interest to examine a series of photomicrographs at 100 diameters magnification, representing the various structural changes in steel during manufacture from ingot to finished forging and exemplifying the effect of the heating operations necessary for the manufacture of a forging from an ingot.

Fig. 6 shows the microstructure of an ingot of Widmanstatten structure and indicates slow cooling from a high temperature. Fig. 7 is the microstructure of a forging in its condition as forged; Fig. 8, the microstructure of the forging after having been annealed for machineability; and Fig. 9, the microstructure of the forging after final heat treatment.

For a matter of laboratory reference a series of micrographs was made to show the structure of iron with practically no carbon and steel containing carbon up to 1.05 and to show the increase in pearlite with the increase in carbon content of the metal. This series is shown by Figs. 10 to 20 inclusive.

Fig. 10, iron which contains carbon, Fig. 11, contains 0.10 per cent carbon, and Fig. 12 contains 0.20 per cent carbon.

Each succeeding micrograph represents steel containing carbon 10 points higher than the one preceding. The increase in pearlite with the increase in carbon content is readily noticed and the decrease in ferrite up to 0.90 per cent carbon also is apparent. The white net work in the micrograph representing the 1.05 per cent carbon steel, Fig. 20, is cementite or free iron carbide.

Some time ago users of rivet steel complained that the heads of rivets either broke off or split after riveting. Representative rivets were examined with the microscope, Fig. 2 showing a typical structure found. That this steel was badly overheated is self-evident. Investigation as to the manner of heating proved that the users had been accustomed to working with low carbon rivet steels whereas these rivets were of high tensile properties, the carbon running from 0.25 to 0.30 per cent and when heated to the same temperature as low carbon rivets became very much overheated, thereby causing the breaking off and splitting of the heads. The consumer was cautioned not to heat the balance of this shipment of high tensile rivets to such a high temperature and future occurrence of the trouble was avoided.

An interesting experience is recalled with one of the foreign inspectors several years ago when he took a tensile test from each end of a ½-inch round bar and obtained 89,000 pounds per square inch tensile strength at one end and 124,000 pounds per square inch at the opposite end. He was very much concerned at this variation in physical properties in the same bar and asked that a microscopic examination be made to determine the cause of this variation. The inspector was an experienced metallographist himself. The two test bars were examined with the microscope at 100 diameters and the low tensile bar appeared to be about 0.30 per cent carbon steel and

the high tensile bar about 0.55 per cent carbon. Fig. 21 represents the structure of the bar showing 89,000 pounds per square inch tensile strength and Fig. 22 shows the structure of the bar having 124,000 pounds per square inch tensile strength.

Since no reason was apparent for such a wide variation in carbon content between the ends of a rolled bar of this small diameter, further investigation was conducted. Both of these test bars were annealed at the same time in a small electric furnace to a temperature above the critical point and after repolishing and etching examination showed the microstructures of each to be identical, as shown by Figs. 23 and 24. The analysis of the heat from which this bar was made was about 0.30 per cent carbon and the microstructures represented by Figs. 23 and 24 also indicate a carbon content of about 0.30 per cent. The fact that identical microstructures were obtained from each of the tensile specimens after annealing above the critical point indicated the cause of the original variation in tensile strength to be due to nonuniformity of annealing the mill length bar after oil quenching.

The end having 124,000 pounds per square inch tensile strength, had been annealed at a low temperature, and the opposite end having 89,000 pounds per square inch tensile strength was overannealed. This lot of bars was retreated with special attention paid to annealing them uniformly and they passed the required test and were finally accepted. This brings up the point of the uncertainty of judging the percentage of carbon in steel from its microstructure. It is possible to make a fair guess when all steels have been annealed at a uniform temperature but in the case just described the carbon was identical at both ends of the bar, whereas, judging from the microstructure the carbon appeared to vary by 25 points.

This recalls a case which proves that it takes considerable courage to interpret a micrograph without knowledge of the history of the specimen it represents. At one time the author was asked by one of the newly employed chemists to tell him what a certain picture he had in his hand represented. This picture appeared to be a photomicrograph of steel but it was not wise to give him an opinon of the structure without knowledge of what it represented. He was told however, that it resembled steel of about 1.10 per cent carbon after etching with sodium picrate, which darkened the cementite boundries leaving the pearlite crystals white.. Being asked what it did represent, the chemist stated it was a sample of Tennessee mud after having been rained upon and dried in the sun, causing it to crack into crystalline form. Fig. 34 is the photograph shown by the chemist, it being 1/6 of the actual size of the mud cakes. This similarity naturally aroused interest, thus a search of the files was made and a photomicrograph of a 1.10 per cent carbon steel taken after etching the steel with sodium picrate found and matched with the picture of the Tennessee mud. Fig. 35 shows the microstructure of this high carbon steel magnified at 300 diameters. Examination proves that the size, type and general appearance of the crystals are identical; so much so, in fact, that they could have been taken from the same object. Here we have a picture of mud 1/6 size and a picture of steel magnified 300 times so nearly alike that they could almost have been printed from the same negative. It is interesting to note if the

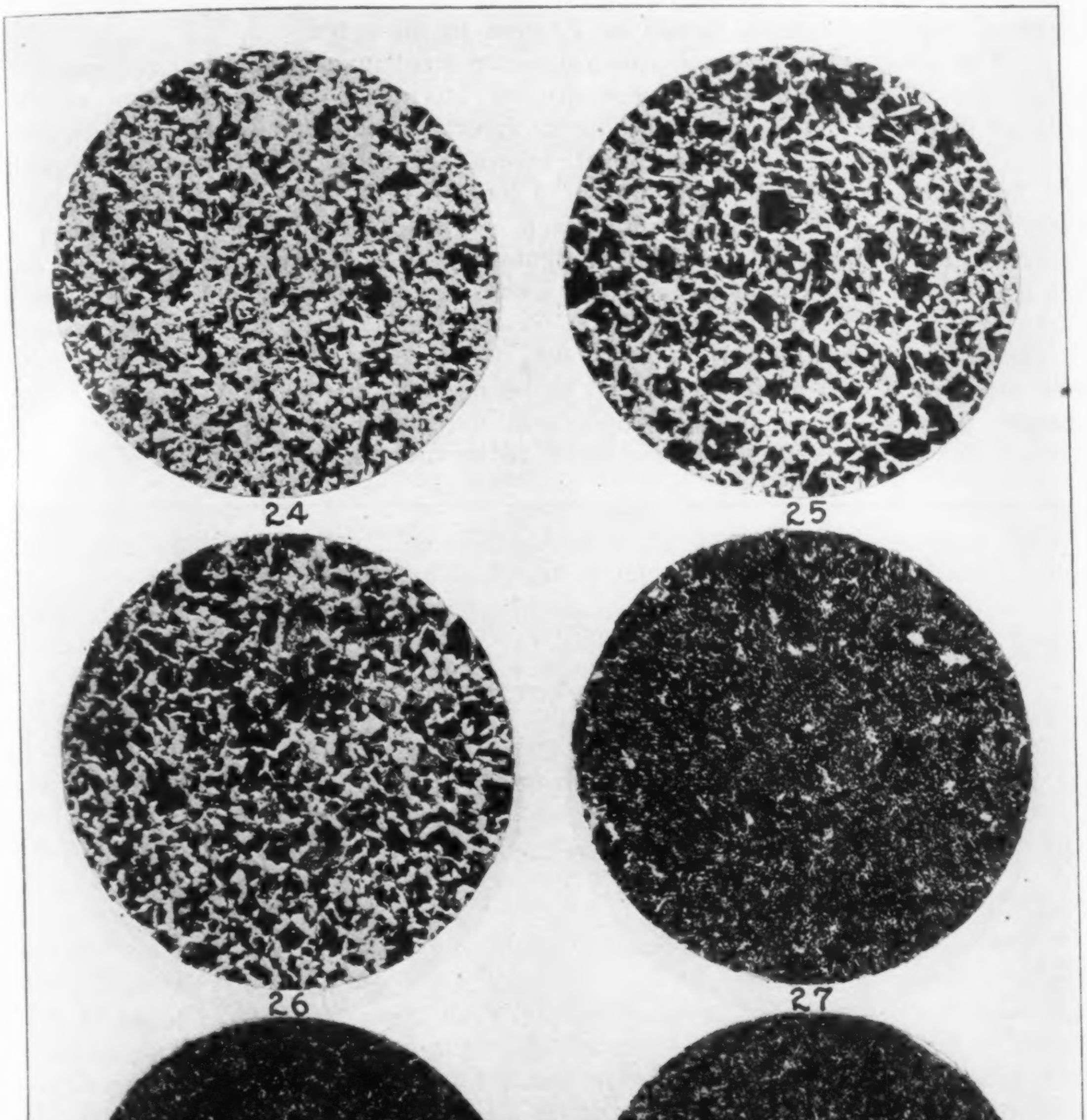


Fig. 24—Structure of test bar, Fig. 22, after reannealing with low tensile bar × 100. Fig. 25-33—Photomicrographs of 0.55 per cent carbon steel quenched at various gradients from 1300 to 1800 degrees Fahr. Fig. 25—Quenched at 1300 degrees Fahr. × 100. Fig. 26—Quenched at 1350 degrees Fahr. × 100. Fig. 27—Quenched at 1400 degrees Fahr. × 100. Fig. 28—Quenched at 1450 degrees Fahr. × 100. Fig. 29—Quenched at 1500 degrees Fahr. × 100. All specimens etched with picric acid.

mud crystals were magnified as many times as the steel photomicrograph the size of one mud crystal would be 75 feet in diameter.

The microscope is a valuable aid to the steel investigator but the example just shown emphasizes the necessity of having a full knowledge of the object in question before an intelligent interpretation can be made. Another case of interest is that of a lot of several thousand miscellaneous forgings of high carbon steel carbon content 1.10 per cent, varying in weight from approximately 10 to 20 pounds each. These forgings were to meet a specification of over 18 per cent elongation in 2". They were quenched and annealed and the tensile bars broke short, having elongations of only from 7 to 9 per cent with no contraction of area, and the fractures were coarse crystalline. A number of retreatments were resorted to without benefiting the elongation and as there seemed to be no hope in passing the steel it was finally put up to the metallographist to determine the cause of brittleness which the heat treatment man claimed to be due to poor steel. Fig. 36 is a

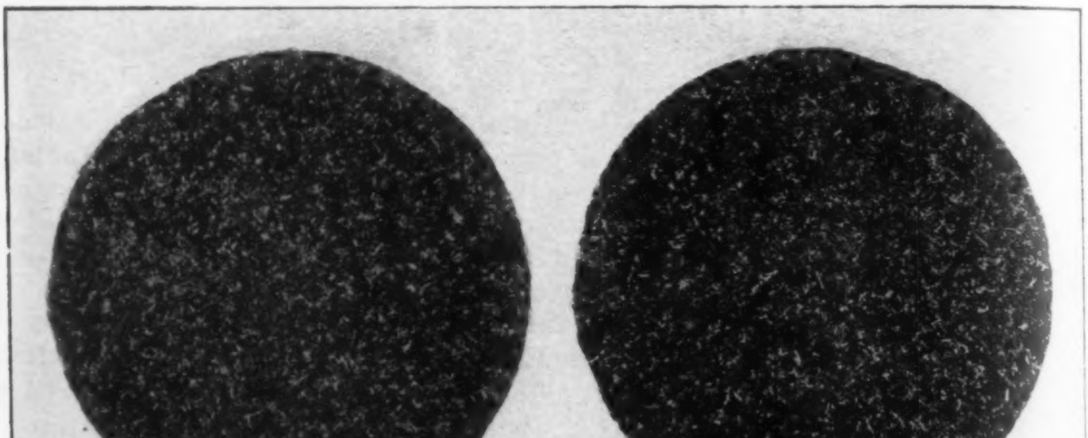


Fig. 30—Photomicrograph of 0.55 per cent carbon bar quenched at 1550 degrees Fahr. × 100. Fig. 31—Quenched at 1600 degrees Fahr. × 100. Fig. 32—Quenched at 1700 degrees Fahr. × 100. Fig. 33—Quenched at 1800 degrees Fahr. × 100. All specimens etched with picric acid.

micrograph of this steel magnified 300 diameters in its unacceptable condition. The specimen had been etched with sodium picrate turning the grain boundaries dark, and shows that each crystal was surrounded by the brittle microconstituent, cementite.

Acting on the theory that cementite goes into solution at about 1600 degrees Fahr., it was suggested that the forgings be retreated by heating to this temperature, soaking thoroughly, and then quenching in oil to keep the cementite in solution. This was done and the forgings were reheated afterwards to the proper hardening temperature and oil quenched, followed by an annealing at about 1100 degrees Fahr. As a result, 132,000 pounds per square inch tensile strength was obtained with elongations well over 18 per cent. Fig. 37 shows the microstructure of this steel after the double heat treatment. The specimen was etched with sodium picrate and shows that the cementite is in small well scattered specks.

Cementite, having a theoretical tensile strength of 5000 pounds per square inch and no elongation when it occurred along grain boundaries, caused weak junctions between the pearlite crystals thereby accounting for the brittle condition when these forgings were improperly treated. After being broken up into small disseminated particles, as just explained, the cementite did not have this weakening influence and sufficient ductility was obtained by correct heat treatment so that these several thousand forgings were finally accepted.

Many heat treaters assume the quenching temperature for a certain grade of steel coming within specified chemical limits of carbon, manganese and the other elements, to be uniform regardless of heats. This is true to a certain extent but for certain grades of steel for special purposes it is not true. Variations in quenching temperature of 10 to 20 degrees Fahr., either too high or too low, at times will influence the service properties of certain parts. For important parts the proper quenching temperature should be determined for each heat of steel used and also for the different sizes of stock from each heat of steel.

A most practical method for determining the correct quenching temperature is to select a number of specimen bars from a heat of steel and heat one of them to a temperature known to be at or just below the critical point. Heat another bar to a temperature 25 degrees higher, increasing each bar by about 25 degrees until a point well above the critical point is reached. Quench these bars at the various temperatures and then fracture them. The correct quenching temperature for that stock can be determined from the appearance of these fractures. This can be demonstrated best by a series of photomicrographs which have been made from steel of 0.55 per cent carbon and representing bars quenched at temperatures ranging from 1300 to 1800 degrees Fahr. For convenience in sawing and examination, all the bars were annealed together at 175 degrees Fahr., which did not effect the variation in grain size obtained by the various quenching temperatures. All micrographs are magnified 100 diameters.

Fig. 25 was quenched at 1300 degrees Fahr.; Fig. 26 at 1350 degrees; Fig. 27 at 1400 degrees; Fig. 28 at 1450 degrees; Fig. 29 at 1500 degrees; Fig. 30 at 1550 degrees; Fig. 31 at 1600 degrees; Fig. 32 at 1700 degrees; and Fig. 33 at 1800 degrees. Upon studying these photomicrographs, it will be noted that up to 1350 degrees Fahr. the quenching temperature was too low and at 1400 degrees Fahr. the steel partially responded although

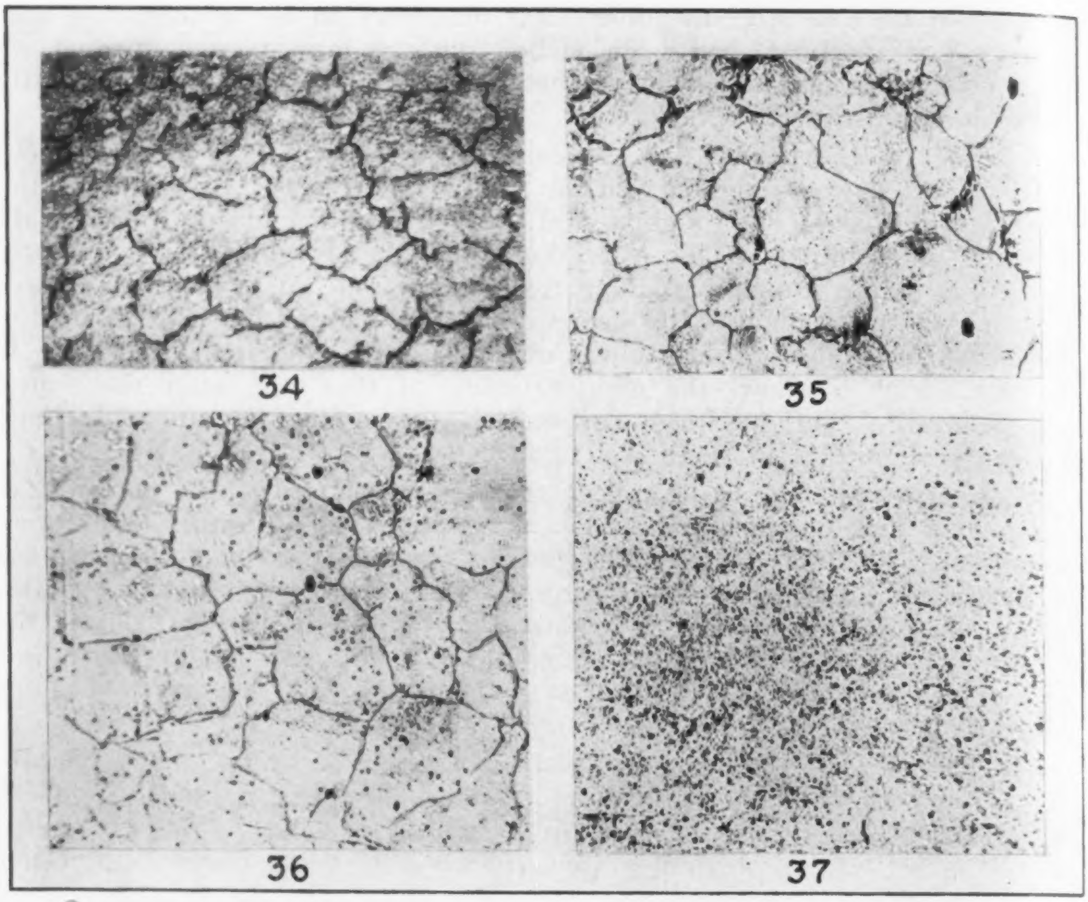


Fig. 34.—Photograph of dried Tennessee mud, 1/6 actual size. Fig. 35—Photomicrograph of 1.10 per cent carbon steel × 100. Etched by boiling with sodium picrate. Note the similarity to Fig. 34. Fig. 36—Microstructure of 1.10 per cent carbon steel of low elongation × 300. Fig. 37—Microstructure of 1.10 per cent carbon steel of good elongation × 300.

there was still some free ferrite remaining, indicating the quenching temperature was not quite high enough. The best grain refinement for this steel was obtained in the bar quenched at 1500 degrees Fahr., although this temperature is well above the critical point of the steel which was approximately 1360 degrees Fahr. The size of this bar was 2 inches in diameter but regardless of its actual critical point we have determined by this method the proper quenching temperature for a 2 inch section of this heat of steel. The correct temperature of say a ½-inch diameter bar from the same heat of steel would be considerably below 1500 degrees Fahr. It is important, therefore, to determine in some such manner as this the correct temperature for important parts of various sizes from the same heat of steel.

There is the old saying about "an untreated alloy steel or an improperly treated alloy steel being inferior to carbon steel" which contains much truth and, therefore, if an alloy steel is not properly treated the value of the alloys is lost. A properly treated alloy steel, however, has service properties superior to carbon steel and in this case it is well worth while to pay the additional cost as this grade will far outlive the ordinary grades.

Fig. 3 is a reduced photograph of the fracture of a broken nickel steel drop hammer piston rod. This fracture is representative of a quite usual

type of a fatigue failure. The nucleus of this fatigue was at the surface of the bar and it finally grew inward during continued service until there was not sufficient cross section to keep the bar intact and it finally caused complete fracture. This case came up as a complaint some years ago, the user of the steel being a new customer who ordered nickel steel bars of certain sizes which, as is recalled, were about 3 or 3½ inches in diameter. The producer was not advised as for what the customer intended to use the steel and, therefore, the order went through in the regular manner and the bars were shipped in the annealed condition, having received a simple annealing for machineability. Some time later a complaint was received that this socalled "special alloy steel was the worst material they had ever used, it being inferior to wrought iron and brass." Investigation proved that these bars had been machined into pistons for drop forge hammers. One broke after five hours service; another after 20 hours service, while a third lasted almost five days. After machining into pistons they had received no heat treatment.

It so happened that some steel from the same heat and not having been machined, was still available and was sufficient to make seven piston rods. This steel was returned to the works upon the producer's request, given an oil treatment and annealing and was reshipped to a customer who machined them into pistons, installed the pistons in drop forge hammers and as far as is known, "they may still be in service as the last report received was they were very satisfactory." This illustrates a case where the nickel steel was unsatisfactory for service in its annealed condition; which can be considered for this purpose in its untreated condition, and how the same steel was made satisfactory by the proper heat treatment.

Fig. 4 shows the fracture of a failed rivet set which had not been uniformly hardened, the chill being thicker at some portions than others causing it to fail after short service. This caused a fatigue failure due to unequal strains on account of nonuniform hardness. This same steel uniformly hardened at the right temperature will give satisfactory service.

Fig. 5 represents a peculiar type of fatigue break occurring in a hardened steel roll. This break grew in a peculiar manner assuming a fossil fern shape. The author does not know how this occurred, it being a new type seldom occurring, but it is shown merely as another freak of fatigue.

From the standpoint of the steel manufacturer, it will be understood readily that naturally he is interested in having the steel he produces heat treated in the best possible manner that is practicable. The responsibility for failures due to metallurgical defects such as serious segregation, pipe, etc. unquestionably rests with the steel manufacturer. There are, however, many cases of failures due to faulty heat treatment or poor design which can not be attributed to the steel manufacturer but for which many times he is asked to pay the cost. However, since the science of heat treatment is advancing, these cases are fewer in number.

MAKING THE MOST OF HIGH SPEED STEEL

By A. J. Wilson*

(A Paper Presented Before the Indianapolis Chapter)

High speed steel is of vital importance to all lines of manufacture, for there is no manufacturing concern that is not more or less interested in the use and conservation of tools and tool steel. This applies more especially to the automobile or automobile parts manufacturer whose tools, particularly high speed steel tools, are a very large item of expense.

During the war when the price of high speed steel was very high, we were awakened rudely to the fact that we were using this material in an extravagant manner. As production of war material was the important demand at that time, the only alternative was to buy more steel as needed. But we also got busy to find some means of making this high priced steel stay on the job longer and to do more work while it was on the job.

As it was necessary to have a starting point, this was made at the blacksmith forge. Due care was taken that heats were satisfactory when the forging was done. One point that the forge man must make certain is that his steel is heated through uniformly. The outside may be up to forging heat and the inside many degrees cooler. The effect of this can be appreciated readily if a piece of steel in this condition were to be put under the hammer. The outside being softer than the center would prevent the hammer blows from displacing the metal in the center of the piece, therefore it would cause a number of small ruptures which undoubtedly would cause trouble in hardening.

No tools should be hardened direct from the forging operation, but should be annealed before hardening. To save time this may be done by heating them to about 1650 degrees Fahr. in the forge fire and then burying them in ground mica which for convenience can be kept in a cast iron box near the forge. Air slacked lime also will answer the same purpose.

After being annealed the tools are ground before hardening, so as to have the least possible amount of stock to remove after the hardening operation. In hardening high speed steel the advantages derived from proper reheating cannot be overestimated. Preheating to 1450 to 1550 degrees Fahr. in a slow furnace and then bringing the heat up quickly to 2250 to 2300 degrees Fahr. in another furnace generally gives satisfactory results. Although in the case of an intricate tool which is liable to crack, better results may be obtained by two preheats, one about 1450 degrees, another about 1750 degrees Fahr., and from this placing the tool into the hardening furnace. Handling the tool in this manner, the shock of being transferred to the hardening temperature is not so great and aids by not causing quick expansion of the thinner sections which naturally heat the more rapidly.

The supposition that any fire is good enough for a preheat is erroneous, because the same care must be exercised in running a furnace for preheating as for final heating if best results are to be obtained and the tool is to come out free from scale. Tools must not be allowed to soak in the preheating furnace.

As a quenching medium, fish oil, a standard soluble quenching oil or coal oil will give good results. Coal oil is a little more drastic and it must

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be used with some caution on account of its inflamable nature. For turning tools, boring tools and the like, where points only are hardened and a little scale does not matter, an air blast will be found satisfactory provided that the air is free from moisture.

During the past few years much experimenting has been done in tempering or drawing back of high speed steel tools and it is along this line that the most improvement has been made. Drawing back has been a common practice for years but not to the extent that it is now carried on. It has been found that steel of standard make when properly hardened, using as high a heat as can be used safely, then drawing back to 1050 or 1100 degrees Fahr., will give its best service. This applies more directly to tools doing extremely heavy work and those required to remove a large amount of metal. The tool is tougher and stronger, still retaining its original hardness, and is not given to crumbling on the cutting edge.

With tools required to give a smooth finish and take a light cut, drawing at so high a temperature is not recommended but a draw of approximately 425 degrees Fahr. in oil has been found to give satisfactory results. A tool drawn at this temperature will retain a keener cutting edge on light work than one drawn at 1000 degrees Fahr. Drawing through the intermediate temperatures, that is between 425 and 1000 degrees Fahr. has not, to the writer's knowledge, ever been productive of any marked degree of success. In fact if it were found necessary to draw a tool made of high speed steel beyond 500 degrees Fahr., it is preferable to jump to the upper range. A chart put out by a well known maker of steel gives some very valuable information in regard to high temperature drawing. This chart gives 800 degrees Fahr. as the point at which the greatest softness occurs.

Before being put to work tools must be properly ground, care being taken to avoid drawing temper or checking. It is customary to use a dry wheel which should be free cutting and true. If water is used sufficient must be used to keep the tool cool as alternate heating and cooling is very conducive to cracks or small checks which will cause trouble later on.

An occasional bar of steel will contain a pipe or seam. This can be determined easily by the appearance of the crack in the hardened tool and if the bar of steel from which this tool was made is examined, the seam or pipe generally can be discovered without much difficulty. Such a bar is practically worthless, but such cases are rare and most of the failures in tools can be laid at the door of the men who handle the steel after it is in the manufacturing plant. In other words, there is much more trouble due to faulty methods of handling than to defective steel.

Now that the tool is ready for use how can we get the most out of this tool? In using the term tools we are referring to tools for removing metal such as are used in turret lathes, screw machines, engine lathes, etc. In the writer's company there is employed a man whose title is "Turning Tool Supervisor", his duty being that of providing the workmen with proper turning tools.

It might be well to mention at this time that 90 per cent of the work is performed under what is known as the straight piece-rate system. Any one connected with manufacturing where a bonus or straight piece rate is in effect, knows from experience how essential it is to keep workmen supplied with proper tools. The average man working straight day rate will

find little fault with his tools if they are not of proper shape and right hardness. He will probably reduce his feed and speed to the point where they will stand. Put this same man under one of the above mentioned methods and if tools do not stand up he will soon be heard from.

Some time back, this problem confronted our company and after consideration it was decided to appoint some one man whose duty it would be to furnish the workmen with tools properly forged, hardened and ground. By this arrangement a saving on tools was effected and production was increased between 15 and 20 per cent. One of the foremen was selected for this new position and he had a man's size job, for in a shop where this method has never been tried it cannot be accomplished over night. One of his first problems was to gain the confidence of the workmen. Second, he was compelled to sell them the idea that a certain new shaped tool would do the work as well or a little better than a certain shape of their own pet idea. It is also a well known fact that no two workmen will grind a tool alike but this was overcome by using a mechanical tool grinder. Using this as a starting point we were soon able to convince the men that tools could be ground better and cheaper mechanically than by hand.

This point being accomplished, a systematization of work was begun. When a tool was adopted as a standard to be kept in stock, it was given a number and a tracing made of it for the producing of blue prints to compose a file of the growing list of standard tools.

One tool stock room supplies the three tool cribs. From these cribs tools are checked out to the workmen and are to be returned as soon as their job is done. This does away with the old method of each workman keeping an unnecessary amount of tools at his machine, a system which is very costly. Each department is equipped with an emery wheel stand to be used in resharpening tools while in use, this being the only grinding done in the machine shop as all tools are shaped up and ground when they are checked out to the workman.

When a tool is broken or ground beyond resharpening, it is turned back to the crib and replaced by a new tool. These broken or worn tools are kept in a place by themselves in the crib until they are collected by the tool supervisor who has them salvaged by being reforged into some other tool using a lesser amount of steel or welded onto carbon steel shanks.

Tools that have been reforged and ground away until they are about 4 inches long are considered ready for the electric welder where they are welded onto carbon steel shanks in an electric butt welder. Very little has been written about this method of salvaging tools and from what data has been gathered in the past year or so, we find that very few firms have taken up this method of salvaging worn out turning tools, crop ends of bar stock, etc. Before going into the cost of salvaging this steel by welding, it might be well to explain the method used in preparing tools and shanks for welding.

We will take for example a piece of high speed steel ¾ x 1 x 8 inches long, which length represents the majority of our tools. Of this length, approximately 4 inches is used, leaving 4 inches, which if not suitable for reforging into some other tool formerly was sold for scrap. At the length of 4 inches the average tool is of no further use as it cannot be held successfully in a tool post or other clamp while in use. These scrap or crop

ends are taken to the blacksmith forge where the forged end is cut away with a hot chisel. Then it is taken to a grinder where the ends are ground at right angles with the sides. It is now ready for being welded to a carbon steel shank, which shank is made from 0.25 to 0.35 per cent cold-rolled carbon steel.

For tools larger than ¾ x 1 x 8 inches it is advisable to use shanks of higher carbon. Our experience in welding heavier tools has been quite limited, but we have been informed by good authority that steel containing 50 to 60 per cent carbon is satisfactory for welding onto heavier tools up to 2 inches square, such as tools used on large planers, boring mills, wheel lathes, etc.

The value of a solid high speed steel tool of the size just stated, is as follows. One piece ¾ x 1 x 8 inches weighs approximately 1.7 pounds and costs about $1.00 per pound or $1.70. To this we add cost of labor plus 50 per cent overhead as follows:

Forging	$0.10	
Grinding	.05	
Hardening	.04	
Total labor		.19
Overhead		.095
Price of steel		1.70
Total cost of tool		$1.985

This is practically $2.00 for a small tool ready to be put to use. Of course the labor figures are only approximate, but will come very close to actual cost, and the overhead will vary in different plants.

Now let us find the cost of a tool of the same size, one half high speed steel and one half carbon steel. One piece of the high speed steel ¾ x 1 x 4 inches weighs 0.85 pounds which at $1.00 per pound represents $0.85. One piece of carbon steel of the same size, weighing about 0.80 pounds at $0.07 per pound represents $0.056. Further costs are as follows:

Cutting off carbon steel from bar	$0.01	
Welding	.015	
Annealing	.03	
Forging, hardening and grinding	.19	
Total labor		.245
Overhead		.12
High speed steel cost		.85
Carbon steel cost		.056
Total cost of tool		$1.271

From these figures we find that where as our tools of solid high speed steel costs $1.985, we can produce a tool of one half high speed steel and one half carbon steel welded on which answers the same purpose for $1.271 with a net saving of $0.714.

Now let us see how cheaply we can produce a first-class tool from scrap formerly sold at $0.10 per pound, that is a tool of the same size worn down to 4 inches in length or too short to hold in a tool post. The cost is as follows:

Cutting off forged end of worn tool	$0.015
Grinding end square	.01
Electric welding	.015

Annealing	.03	
Cutting off carbon shank	.01	
Forging, hardening and grinding	.19	
Total labor		.270
Overhead		.135
Cost of 0.85 pounds high speed steel at $0.10 per pound		0.85
Cost of 0.80 pounds carbon steel shank at $0.07 per pound		.056
Total cost of tool		$0.546

Thus we find that we have the following results:

Tool made from solid high speed steel	$1.985
Tool made from one half high speed steel and one half carbon steel	1.271
Saving	$0.714

Now we have produced a tool by salvaging for $0.546 with or a direct saving of $1.439 over a solid tool of high speed steel, also a saving of $0.725 over a tool welded up from a piece of steel representing 100 per cent value.

One peculiarity arises in welding high speed steel and carbon steel, that must be overcome, and that is; one will heat faster than the other owing to the difference in resistance. This will occur in any two pieces of metal that are of different composition. This is overcome by allowing one to project further from the holding dies than the other until they seem to heat evenly to a plastic heat, then they are pressed together. The amount that they must differ in length to get proper heat at welding points can only be determined by experimenting.

As soon as the welding is accomplished they must be annealed. This is best accomplished by placing them in a hot furnace, holding them at a good annealing heat for an hour or more, then letting them cool down slowly in the furnace. If a piece of high speed steel and carbon steel when welded together is allowed to cool in the air, one will cool quicker than the other, and as contraction takes place during cooling it is bound to set up a strain in the weld which will cause it to crack. This will be true five times out of ten, thus it does not pay to take any chances. Tools properly welded and annealed can be forged successfully and it is our experience that less than 0.5 per cent break in forging.

In placing these tools in service, precaution should be taken to see that the bed of the tool post is level and smoothed where the tool is clamped down or it may be broken in this way. This is equally true of any high speed steel tool that has been hardened all over.

The habit of workmen in striking a tool with a hammer when it is necessary to move it cannot be condemned too strongly. It is much better to take a little longer, relieve the tool and reset it, as a broken tool costs money and time and produces nothing but waste.

In conclusion, the price of success is eternal vigilance. Workmen, as a rule, do not take interest in the use of tools, and the practice of economy as that shown by the man who is responsible for the success of the department or the man who pays the bills, but much can be done along the line of educating machine operators in lines of careful handling of tools. They must be taught that every direct loss sustained by the company is an indirect loss to every individual connected with the firm.

HEATING AND QUENCHING HIGH SPEED STEEL

By A. E. Bellis*

(A Paper Presented Before the Boston Chapter.)

One of the recent developments in our civilization is the recognition of the importance, capacity and power of proper large scale organizations. While these have their defects, we all see their advantages. No better example of these can be cited than their power in getting arms and men to Europe so that this country could play its decisive part in the war. The lesson that the steel treater can draw from this is that by organized co-operation with others of his craft he can increase his power and ability and advance his art many times more effectively than by the old secretive process of isolated efforts. One of the greatest problems for co-operative investigations by this heat treating fraternity is the development of a satisfactory theory on which to establish exact and reliable practice for heat treating tool steel.

It is very important that our fundamental conceptions and conventions be correct. Have you ever considered how much confusion would have been avoided if the race had always used the best units for measuring time, length, weight, etc., instead of slowly evolving some compromise systems? How many centuries did it take to establish our present time measuring system of units, years, months, days, etc.? How convenient it would be if we had a number system of eight units instead of ten, so that most of the unwieldy fractions that bob up in our decimal system would be eliminated. How much confusion would be avoided if we had one entirely satisfactory temperature scale? The history of every science gives illustrations of the importance of exact foundations to make the future structure progress symmetrically without requiring the tearing down of misconceptions from time to time.

A review of the history of the art of hardening of tool steel can be made very briefly, and is of interest in explaining some of our present theories and practices. It is surprising how few radical changes and how few important developments are found. Before 1700 there was a volume of literature on the art descriptive of all kinds of quaint and imaginative processes and theories on the hardening of steel. It seemed to be well recognized at that time that the rapid quench or rate of cooling from a high temperature was necessary for hardening. One writer stated, however, that the best hardening resulted from quenching in an infusion from the roots of blue lilies, and that softening of the steel resulted from quenching in an infusion from the common bean. Francis Bacon attributed the hardness to its "youthfulness of spirit"—a phrase that suggests the fatigue phenomenon that is still a mystery although we have established some solid facts and eliminated considerable of the superstition connected with it.

In the eighteenth century the chemists believed in the phlogiston theory and thought that putting phlogiston or heat energy into iron changed it to steel. In 1721 Reaumer suggested the first physical chemical theory to account for hardening, in opposition to the phlogiston theory. He believed that heat drove out "sulphurs and salts" making the iron more compact, and that these salts returned upon tempering. In 1781 Bergman, who believed in the phlogiston theory, demonstrated that steel contained 0.20 per cent of plumbago (carbon) and suggested that

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this might cause a polymorphous change in the iron. While he confused phlogiston with the plumbago, his views were the foundation for our present theories. Shortly after this time Bertholet and Lavoisier demonstrated the elementary nature of carbon and oxygen, so that the phlogiston theory no longer reigned, and the foundation of our present chemical science was firmly established.

During the next 50 years many experiments were made to harden steel with the carbon of the diamond, without any important results from such costly experiments. The relation between the carbon content and hardening power of the steel began to be recognized, and a quantity of excellent empirical data on steelmaking and hardening developed. In 1864 Sorby's wonderful work with the microscope opened up the metallographic field and the results of improved microscopic technique led to the recognition of the "pearly constituent" of soft steel, to Martens' identification of the constituents of hardened steel and to all the results of such later workers as Howe and Sauveur in which the significance of the physical orientation of the proximate components came to be definitely understood. This work was supplemented by the information gained from heating and cooling curves and the recognition of transformation points and their relation to rate of cooling or quenching and structure.

The practical development of tool steel began to make real progress in 1870 when the first special tool steels were produced. These were high carbon steels with the special elements, manganese, tungsten or chromium added, which gave the steel the property of self hardening. These steels had a cutting efficiency two and one-half times greater than the plain carbon tool steels. Real high speed steel was not discovered until 1900, when Taylor and White found that the medium carbon, high tungsten steel when heated nearly to fusion gave a cutting efficiency six times that of the ordinary carbon steels. There have been countless experiments varying the proportions of the essential elements to find the best composition for high speed steel. The standard brands now have approximately 17.0 per cent tungsten, 3.0 per cent chromium, 1.0 per cent vanadium and 0.55 to 0.70 per cent carbon. There are many variations from this analysis but this will be considered as a typical high speed steel in the following discussion.

The unique property of this steel is its ability to work red hot without losing its temper and this red hardness of high speed steel is its valuable property. The limitation of cutting speed on the plain carbon tool steel is the tempering or softening of the tool if run fast enough to heat above 400 degrees Fahr. Some high speed steels actually increase in hardness and cutting efficiency on heating up to 1150 degrees Fahr. This secondary hardening is a complex property depending on composition and heat treatment that has not yet been satisfactorily explained. The actual hardness of high speed steels is not an indication of their cutting efficiency. Taylor, who discovered these steels and studied them extensively, states that the best all round high speed cutting tool can be filed with a hard carbon steel file. It is good policy, however, for the heat treating room to turn out high speed tools that will resist the mechanic's file test. This brings us to the consideration of the heat treatment of high speed steel tools.

It is necessary to heat these steels to very near the melting point in order to get them properly hardened. The old blacksmith used to get

this heat in the coal forge and, to insure enough heat, used to actually melt the corners of the lathe tools he hardened. By regulating his draft he was able to avoid excessive scaling and oxidation. The use of high speed steel for fine edge tools, small reamers, milling cutters, etc., has resulted in the development of more refined methods and careful technique. It is now recognized that properly controlled conditions are as necessary for getting the best results from high speed steel as are necessary for other tool steels.

Too long or too high heating coarsens the grain with resulting weakness and brittleness, while insufficient heat will not develop the best red hardness properties. The best structure is the finest grained complete austenite, which results from a minimum time at the lowest temperature that will give this complete transformation. Under the microscope, properly etched samples of hardened specimens will show a distinct net work of polyhedral grains at a magnification of 500. Overheating or a little longer time at the high heat than is required greatly coarsens this structure. By making a brinell impression on a polished specimen, the metallographic test can be checked. The over heated coarser grained samples will show minute star-like cracks around the brinell impression.

It is absolutely necessary to have a standardization test of this kind, which should, of course, be supplemented with a fracture test, and if possible by an actual work test in order to be able to control the many variables that affect the steel and its heat treatment. The size of the piece being hardened and its relation to the size of the furnace, the heat capacity of the furnace and the cooling effect of putting in the work, the initial temperature of the piece when it is placed in the high heat chamber; the nature, temperature and location of the quenching bath; the condition of the pyrometer and the relation of the temperature of the fire end to the heating tool are all vitally important considerations. It is evidently impossible to describe the heat treatment of a certain tool by stating that it was heated to 2250 degrees Fahr., quenched in oil and drawn to 1150 degrees Fahr.; for even if the hardener did exactly that, he could ruin the best high speed steel tool if his furnace atmosphere was too oxidizing; or if the piece was left in the furnace longer than necessary. In order to standardize treatments it is necessary to standardize and control all the working conditions.

The possibilities of the salt bath method has always interested the speaker very much in this connection, for it gives an opportunity of getting real equilibrium between the heating medium, the fire end, and the pieces being treated, that cannot be attained in any other way. In a muffle-type furnace or in packed work, there is always a variation of temperature in the different sections of the furnace or of sections of the tool in the furnace. This is a broad statement; but a study of the different times it requires to get the fire end to indicate the best average temperature of the different sections of a furnace, the length of time required to get a true reading, leaving a massive tool in long enough to get actually uniformly heated to the average temperature of the furnace, it will be found that it is practically impossible to get real equilibrium in such a furnace. The practical solution of this difficulty is, of course, to have the furnace hotter than the work, and only leave the work in for the shortest time required to harden the cutting sections. This

is only a compromise method and incapable of giving consistent, uniform results.

A very small piece in a very large furnace will come nearest to giving a satisfactory flow of heat into the steel, but unfortunately such a relation rarely occurs in shop work. In a liquid medium of fused salts this difficulty is overcome. A lower furnace temperature can be maintained with a liquid medium; for, as explained above, the temperature prescribed for hardening in the muffle furnace or in pack hardening, is the temperature indicated by a fire end fixed in the furnace; not the temperature given the tool after the shortest possible time necessary for hardening in the open fire; or the temperature of pieces in the center of the pot packed with heat insulating material in back hardening. In a liquid medium as of fused salts, equilibrium can be obtained between the heating medium, the fire end, and the tool with absolutely no danger of scaling or overheating of small sections. The same heat can be given the tool at an apparently lower temperature because the heat stored in the bath flows uniformly into the steel instead of being pumped in at points of solid contact or by radiation through an oxidizing and poorly conducting gas.

It is rather general practice now to quench high speed tools in molten salt or lead at about 1100 degrees Fahr. though some shops still quench in oil and draw back to 1100 degrees Fahr. The former method minimizes the danger of cracking and still gives the advantage of increased performance by developing the secondary hardness properties. The flow of heat from the tool into the quenching medium should be uniform and this is obviously not possible with water or oils that vaporize in contact with the heated piece.

In quenching, the rate at which the steel cools through the few degrees of its critical range determines the completeness of the change of structure or the success of the hardening. This rate of cooling depends on the quenching medium, its temperature, the temperature of the steel being hardened as it enters the quench, the mass or size of the steel and of the quenching bath. If pieces are very small, and the quenching bath large, by proper agitation a very rapid cooling will occur and extreme hardness result. If such pieces were heated hotter than necessary for complete transformation the effect would be to retard the rate of cooling through the critical range with resulting loss in hardness and also brittleness from grain growth. The nature of the medium, its heat capacity or ability to absorb heat is of fundamental importance.

The fact that small pieces of high speed steel can be hardened when quenched at temperatures as high as 1250 degrees Fahr., shows how much more important is the heat capacity and fluidity of quenching medium than the actual temperature of the quenching medium. The fact that molten salts are stable at these temperatures, and are not volatilized by the contact with the heated piece, make them more dependable for quenching high speed tools than oils or other liquids of lower boiling points.

When the heating has to be done in an open fire or muffle furnace it is highly desirable to have the fuel regulated so that there is a minimum proportion of air, and therefore of oxygen, burning with the fuel when the tools are actually in the fire, in order that the scaling will be minimized. Great care also must be taken to leave tools in for the shortest possible time for the same reason. The time at the high heat can be minimized by making the preheating as thorough as possible.

A great many failures that the hardener cannot help are blamed on heat treating and many times bad steel is blamed for a poor heat treating job. As a matter of fact, the heat treater to be successful has to be a well tempered individual and be willing to go more than half way to overcome troubles. It has been shown that there are over 200 possible reasons why a high speed tool may fail, and the heat treater only directly controls about 10 of these reasons. However, he can modify his treatment and often make faulty steel do passable work.

There is considerable interest being shown at present in the possibilities of cast high speed steel tools. The advantage of eliminating waste in machining, especially in very large form cutters, is obvious, but it has not yet been well established that annealing and heat treatment can give the refinement of grain that is obtained from the rolling and hot working of tools made from bar stock.

For high speed tool work some nonferrous alloys have been developed, mostly alloys of cobalt with metals of the chromium group. These can be used very satisfactorily on certain classes of work, particularly on very hard material and where fine finishing cuts are not necessary. These alloys cannot be machined or heat treated thus tools cast from them have to be ground to shape, and since they are more brittle than high speed steel tools their application is further limited.

CARBURIZING, HARDENING AND TEMPERING HIGH CARBON ALLOY STEELS IN 130 MINUTES

By R. L. Gilman*

(A Paper Presented at the Philadelphia Convention)

Metallurgy, mechanics, and economics should be so correlated that more efficient, more rapid, and more economical production may be obtained. This article refers to a typical complete set of heat treatments for small hot or cold shaped objects of high carbon alloy steels, especially chrome-vanadium alloys, requiring maximum hardness and strength and above all the greatest possible uniformity of both. It is assumed that the stock has been thoroughly annealed previous to working. All statements to follow are based upon practice that has passed the experimental stage.

In speaking of carburizing eutectoid or hyper-eutectoid steels the author is aware that he may be charged with various errors in observation and fallacies in reasoning. Such a hypothesis, however, is permissible on condition that the very hard case produced is not detrimental to the product. It saves labor and time in subsequent operations and is a great aid in securing uniformity of surface hardness and finish. To those whose product will permit such use of the process it may be said that it "hides a multitude of sins," and in addition to hiding them compensates for some of them to a gratifying degree. Having carburized his work one may forget about unavoidable variations in carbon content and decarbonization of stock, and may proceed with precision and speed that will pay amply for the carburization; obtaining a product that is of superior quality by virtue of its uniformity, if for no other reason. Such carburization need not involve a separate heating operation, but may be combined with the high heating that is commonly employed to relieve

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strains of distortion and to promote refinement of coarse structure imparted by annealing the stock.

The 130 minutes includes all time during which a load of 130 pounds of steel is subjected to treatment in heating, carburizing, reheating for hardening, and in tempering operations. Of this time 120 minutes are spent in the carburizing furnace, about 7 minutes in the hardening furnace, and the remaining 3 minutes in the tempering furnace.

The work is handled once only in the entire process, that being in the operation of charging the carburizer. Quenching and conveyance from furnace to furnace and feeding the furnaces are functions of gravitation and mechanics and do not enter into consideration as time or labor consuming operations.

All furnaces are of the gas-fired rotary type automatically controlled within 10 degrees. This equipment gives precision and uniformity in the essential factors of treatment, feed, length of treatment or speed, and temperature. This uniformity is an important time saving feature of the process, rendering possible the use of high temperatures that it would be absurd to use in any other type of furnace. The author hopes some time to try electric rotary furnaces for such work. The electric furnace may be better insulated thermally than the gas furnace, simpler in construction, and may be installed where gas is not available.

The following method of carburizing gives excellent results on a very short treatment. The carburizer is charged at 1602 degrees Fahr. or higher, a small amount of gas is admitted to the retort to expel or consume the oxygen present, and maximum heat is applied automatically. The mass of the work insures slow heating, and the tumbling insures uniform heating of the pieces. At the end of one-half hour, when the work has assumed a low red heat a continuous supply of gas is allowed to flow through the retort. At the end of 2 hours from the time of charging, the work is dumped into oil where it remains only a few seconds, being brought out of the tank by an endless chain of buckets while still at a smoking heat.

Before entering the hardening furnace the work passes through a tank of boiling hot soda solution to remove the small amount of oil that may still adhere to it and to insure entrance into the hardening furnace at a uniform temperature, which is very essential in view of the mechanical nature of the process.

The hardening furnace is operated at some fixed temperature far above the critical range of the work, usually between 1600 and 1740 degrees Fahr., depending upon the size of the pieces of work and the rate at which they are fed through the furnace. Feed and speed of the furnace may be so regulated that the work will drop out at any desired temperature, the exact determination of which requires an optical pyrometer. It is well to pass a few pounds of scrap work or an equivalent run through the furnace immediately in front of and immediately after the work; other wise a small quantity of work will be overheated at the beginning and end of operations, or whenever for any reason the supply of work for the furnace is interrupted.

The use of the high temperatures just mentioned is conditional upon the size and shape of the pieces being treated. Pieces irregular in size or shape, or having thin spots or projections cannot be handled in this way for obvious reason. However, the high temperature is a great time saver and may be used safely upon objects of suitable size and shape. The

saving in time is not a result of forced heating, at least at the lower temperature, but is due more precisely to the elimination of the flat top of the temperature curve. The work is quenched in any suitable quenching medium, removed from the tank by an endless chain of buckets and fed mechanically into the tempering furnace.

The tempering furnace is of the same type as the hardening furnace, and likewise operated at a higher heat than the work can be allowed to reach. As the work falls from this furnace, it is allowed to accumulate in large boxes where its mass insures slow cooling.

The quenching mediums already referred to are cooled by circulation through a suitable external cooling system, and are delivered after cooling directly into the hoppers with the work. Brine pipes in these tanks would be of little use without changes in the equipment provided for receiving the work and carrying it through the tanks. A close inspection of the work after each quenching operation is maintained. This discloses the source of any trouble and usually suggests proper remedial or compensating adjustment of equipment or process.

No grave fears should be entertained regarding the rapid heating of this method, which is far more apparent than real. The load in the carburizer does not reach its critical point, below 1400 degrees Fahr. for more than one-half hour from time of charging, and it does not reach maximum heat for an hour thereafter. This is true regarding either a mass of work or individual pieces. A sort of tapered heat is maintained in the hardening furnace by the constant stream of work entering at a temperature of over 200 degrees Fahr. and rising in temperature as it moves forward. Each piece of work is subjected individually to a gradually rising heat for about 3 minutes, then to a nearly constant heat for about 3 minutes and finally to a gradually decreasing heat for about 1 minute. During this last minute the temperature of the work does not actually fall because it has never risen to the maximum heat of the furnace. This decline in furnace heat gives the work a chance to assume a more uniform internal temperature than would otherwise be possible. In the tempering furnace the conditions are similar to the conditions in the hardening furnace.

Regarding the results obtained by the method outlined the author can say only that they are as good as any he has seen. Since they equal the standards set for high grade bearings, certainly they will be found satisfactory for the majority of other pieces the size and shape of which will permit similar treatment. A true case of appreciable depth is easily shown to result from this treatment, but it is not apparent in the fracture unless the specimen is overheated or etched. It will be understood that this case does not differ much from the core in carbon content. There is no sharp line of demarkation between the case and the core. The case is too elastic to be clipped off. Under the hammer, test specimens never show any flaking or chipping, and often if not always, break internally before they do externally.

In the beginning of this article reference was made to the electric furnace as being desirable for installation where gas is not available. This refers to the use of a substitute for commercial gas as a carburizing agent. This substitute is carbon monoxide gas derived from limestone and charcoal. The author ventured upon the development of this subject and ventures to mention it now with timidity, well aware that such a promising method has probably been investigated from many angles and

rejected for good and sufficient reasons. Several methods of generating and applying this gas have been used with results varying from absolute failure to gratifying success.

This gas may be produced more economically than modern commercial gas and it possesses many advantages for the process just described. However, the details of preparation and application of this gas depend upon the results of further research.

The treatment just outlined does not in any way depend upon the outcome of the experiments last mentioned. In general, this method is admirably adapted to the case hardening of low carbon steels. In such an application, a somewhat longer carburizing time might be required; and an additional heating machine and tank might be needed for special treatment to regenerate the core after carburizing.

THE ROLE OF THE METALLURGICAL LABORATORY IN RELATION TO THE INSPECTION DEPARTMENT

By Earl W. Pierce*

(A Paper Presented by Title at Philadelphia Convention)

By pointing out the value of co-operation and the advantage of thorough and conscientious investigation, an effort will be made to show wherein the laboratory and the inspection department will be able to strengthen their positions in regard to quality production on a commercial basis. There are, no doubt, many instances that could be pointed out which would go to show the lack of co-operation between the inspection department and the metallurgical laboratory, but that would not be of an instructive nature and it is along constructive lines alone that this article will proceed. Therefore, this paper will be an effort to build up a working bond between these departments by which they best can work and agree to further the cause of quality and production.

The metallurgical laboratory as an asset to industries in the field of the metal trades rapidly is becoming recognized as such and making for itself a place which is indispensible in all respects. The position of the chemical laboratories as a requisite to industry has been established to such an extent that it no longer lies in a questionable field as to the advantages thereby derived. It is now time that the metallurgical laboratory must make its mark and continue to do so to hold the position it has attained.

There is no doubt that the recent development in this field owes its source to the demands brought forth on it by the late war. It was then that metallurgists and the practical heat treater were in demand to solve these problems and produce the goods under existing conditions.

Various surveys were made and the methods of handling the work was recorded. It was a great surprise in many cases to find the inadequate and crude ways the work was handled. Many of these conditions were improved and great assistance was brought through the metallurgical laboratories to facilitate the method of production on a large scale which was then required. The credit for such good work was justly given to the metallurgist.

While we again are engaged in peacetime pursuits, the metallurgical laboratory must not rest on its oars and live on its war time achievements, but must rise to the problems of the greater production de-

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manded in the steel industry in this great period of reconstruction. It is universally conceded that the field of metallurgy is in its infancy, so to speak, and the greater developments are yet to come. Therefore, it must keep up its prestige and continue to prove itself capable and an asset to all good industrial methods by showing the constant advantages to be derived from unending research and investigation. The metallurgical laboratories must then be an investigating organization and a source of inspection.

Heat treating material and chemical testing of materials have all experienced phenominal growth. War production was the direct influence, and the success of our efforts in the industrial end of the war game was largely responsible for the success of the men in the laboratories. New metals have been invented or created. Special alloys used in the production of some of our war materials were hardly known a few years ago. The metallurgist today is continually looking for new methods or practices in order to find a better way to do a thing.

Present conditions in shop practice indicate the demand for heat treating equipment, chemical and metallurgical laboratories for the main purpose of insuring the product and adding efficiency to the organization. Various plants advertise that they have complete laboratories, thereby guaranteeing their product to the public.

It is thus recognized that the need of such equipment to take care of the increasing demands made on the manufacturer is essential. The metallurgist must proceed to prescribe the proper steels and the proper treatment. After the proper material is selected and the prescribed treatment is given, the material passes on to the final processing, and the degree of success with which it meets in this stage, alone is due to the inspection it receives.

The many types of alloy steel produced in the past year have given the engineer and metallurgist a much greater field from which to choose the materials best adapted to their requirements. It is necessary that the relation of cross section to physical properties be better understood in order that material of proper strength and of as light weight as possible may be selected. Investigation and experiment carried out along these lines has shown that an alloy steel of the milder type is of better quality.

The best steel of this type contains less than 1.0 per cent chromium in combination with about 3.0 per cent nickel and less for parts of 2-inch sections and under. However, the chrome-molybdenum type is now being given greater preference. By the use of such alloy steels, the cost of production alone is reduced by the advantage in the use of smaller section. It is ncessary that these mild steels be selected with care and be subjected to rigid inspection to insure material that has been well made and of the proper physical requirements. Exacting inspection will prove of profit in this particular.

Complete specifications should be made out by the engineering and metallurgical departments showing material requirements, method of procedure and inspection specifications. In this way a standard product can be insured and the metallurgical and inspection departments working together can maintain this standard. It is often the case to find the laboratory under the jurisdiction of the inspection department, but this is only another means of showing the interdependence they must have.

To accomplish the greatest results, the metallurgical laboratory must become an inspection department and work as such in co-operation with the general inspection department. It is absolutely necessary in any industrial organization to maintain the standard and possibly to be a little bit better than the standard. The method of handling this work must then be efficient and thorough in order that finest quality may be assured. Quality, then, must be the first aim from a metallurgical standpoint, and must be insured by the inspection department. Here direct co-operation with the metallurgical laboratory must be evident.

The work in question should be submitted to the laboratory for investigation and the mode of inspection can thus be determined from the results obtained. Instructions can be given to the inspection department to proceed in a manner with testing in accordance with the requirements of the particular work concerned.

It has very often been the case that a certain course of inspection has been prescribed entirely unfitted to the later requirements which the part must meet in service. If the metallurgical department were not co-operating with the inspection department it would not take long for a sufficient number of these parts to get in service and cause the company an unlimited amount of trouble in adjusting such mistakes. There is also the other side, that where the inspection is inadequate. A large amount of work which has been properly heat treated will be rejected to a salvage department where a considerable quantity of perfectly good work may be scrapped unknowingly.

The proper inspection must be decided upon, which includes tests of the following nature; file, sclerescope, brinell and physical, both static and dynamic. It is needless to go into detail concerning these tests but it is sufficient to say that the file may be used with considerable accuracy on certain kinds of work such as cyanide work and case hardened work requiring a hard wearing surface, but where no physical strain will come, and as a comparative test only. It is well to say here that there is a great field for improving instruments or perfecting new ones to measure the relative hardness of metals. The sclerescope test is a much more accurate measure of hardness than a file although it has its faults. The brinell test is a more practical test when possible.

Inspection of case hardened parts by fracture of several parts in each heat will be of great advantage in determining the general characteristics of the kind of work produced. This will give an insight to the quality of heat treatment and will often tell a story which could not be known otherwise. This sort of a test should be left to the laboratory entirely and should be in the hands of a competent man so that any defects can readily be looked into and remedied at once. It is very often the case that this kind of a test is left to an inspector who has no knowledge of what he is doing and therefore has rendered no service whatsoever having only added to the scrap pile.

Physical tests of a static and dynamic nature must be left to the laboratory and are tests which are of more value than the others and determine the strength and brittleness of the parts.

Proper inspection of material from the receiving of the rolled stock until the last processing is essential to good heat treating. The stock when received, if properly inspected for seams and other injurious properties such as piping and segregation, will relieve many troubles in the heat

treatment. It is very often the case that cracks found in forgings after hardening are charged to the heat treater when it is simply a case of neglecting to reject such stock in the first inspection. By keeping strict record of work produced in the heat treating department by submitting a certain amount of samples to the laboratory for examination,—these samples always being taken from parts in regular production—the inspection department can be of great service to the metallurgist in maintaining a check on the finished product.

After the material has left the heat treating department and is delivered on the machine shop floor, the relation of the metallurgist to the inspection department does not need to cease, as often heat treated work may have passed inspection and still give trouble in machining. When such troubles arise it is well for the inspector to report such difficulties to the laboratory so that due investigation may be given the matter and the trouble determined.

It is then a question of knowing the machining qualities of the steel with which you are working and to know the hardness at which it will give the least difficulty possible and still retain the physical properties which are absolutely necessary. Very often in such a case the trouble may be found in improperly hardened tools or still more, properly hardened tools but not properly tempered ones.

To determine when tools and especially high speed tools, are of the proper hardness requires also some experimenting and a knowledge of the grade of steel used in the tool, as at the present time there are so many grades of high speed tools on the market with practically no two of the same characteristics. This then goes to show that the inspection department by working with the laboratory in such matters, can save a great amount in time and labor by calling a man who is familiar with such cases and can then adjust the treatment of the steel to more satisfactory processing.

There is one thing that must be watched in machine shop troubles and that is in ordinary times of production the machine is set for certain speeds and feeds to take care of the hardness of the steel as it comes when treated in the regular manner which however may be a little high for rapid work but still well within the limits of good machine shop practice. An order comes to speed up production and, as you would expect, the cry comes that the stock is too hard and that the heat treatment is at fault. The cause is very evident and it is only a case of inspection to show the existing hardness and as is usually the case, the material is found to be of correct hardness. It is simply a case of adjusting the machine for the object desired.

In the case of failures of parts due to unknown causes, all such defective parts should be turned over to the laboratory to determine, if possible, the cause and to remedy any methods which tend to bring about such failures. Very often such causes occur from segregation of impurities, blow holes and piping in the original stock. Again such failures may be due to cold shorts, burning and pitting in the process of forging and heat treating. In every case, however, it is essential that the inspection department inform the laboratory of such cases and submit the faulty pieces for examination. In these cases the laboratory only is equipped to handle such work and in such work the microscope proves itself invaluable.

The difficulties experienced in grinding case hardened parts present problems which are not easy to solve without some investigation. Grinding checks are of very common occurrence and more often progress beyond the stage of checks and become case lifting. It is very common practice to put the blame of such work on to the case hardener and say it is caused in the treatment. The author is not of this opinion and believes that a great majority of this trouble can be traced to improper grinding which is directly caused by rushing the work in an effort to increase production, especially where the work is on a piece-work basis.

Such troubles when noted should be brought to the attention of the metallurgist and should be investigated and if hardening operations are inadequate to take care of the part in question, a change can be made to eliminate or greatly lessen the trouble. However, it is well to look into the various grinding conditions as very often the seat of the trouble is a lack of good grinding knowledge in regard to the kind of wheel to use and also the right speed. Faulty use of the grinding medium is a very common cause as well as the lack of frequent wheel dressing.

As the various tests which should be made on heat treated and case hardened steels for the best quality are so distributed between the metallurgical laboratory and the inspection department, it is absolutely necessary that one supplement the other and co-operate to the common good of all concerned. In this way can quality and production be linked together, and in the end, production must be maintained and not held up. It is in the fact that the laboratory, through the aid and co-operation of the inspection department, can produce quality and not hinder production, that it will make its strongest stand.

EDUCATIONAL CO-OPERATION

In April last year F. C. Lau, of the Chicago Chapter and since last May its chairman, proposed that an effort be made to induce at least two of the technical schools of Chicago to offer evening courses in the forging and heat treatment of steel. After a tentative plan had been prepared and after Mr. Lau had become chairman of the Chapter an Educational Committee of three, consisting of T. E. Barker, chairman; E. J. Janitzky and C. P. Berg, was appointed with power to act for the Chapter in such dealings as it might consider desirable with such educational institutions as would seem likely to serve the community beneficially in offernig the courses which were proposed.

Here is published the experiences of this committee and the schools and the results attained by their activities, believing that the information may be helpful to other chapters which may find similar movements in their communities desirable.

The first move by the committee was to state its proposition to the Deans of the Armour Institute of Technology and the Lewis Institute both of whom felt kindly toward the scheme but were at a loss for available talent in their faculties to handle such classes. The committee then proposed that instructors be furnished from the membership of the Chicago Chapter, that is, technically trained men professionally employed in the practical work at local industries. This was approved by the Institutes and from that day to the present the Educational Committee has been a very busy one.

The tentative plan, which became the final plan, was to embrace the following subjects in the course:

Pyrometry
Metallography
Forging (Effects on Structure)
Annealing
Alloy Steels
Hardening and Tempering Tool Steels
Case Hardening

Volunteers were called for in open meeting and by mail and a generous response was received. Subcommittees of three each were appointed to select and prepare texts for each of the subjects of the course, as outlined above, and present them to the classes.

Claude S. Gordon of Claude S. Gordon & Co., accepted the chairmanship of subcommittee on "pyrometry."

R. W. Burleigh, metallurgist, U. S. Ball Bearing Co., took the chairmanship of the "Metallography" subcommittee.

F. C. Lau, secretary, Arrow Forge & Tool Works and Chairman of the Chicago Chapter was chairman of the subcommittee on "Forging."

William Finkl, metallurgist, A. Finkl & Sons Co., with his committee handled the subject of "Annealing."

The subject of "Alloy Steels" was handled by E. S. Brown, metallurgist, Miehle Printing Press & Mfg. Co., and his committee.

Harry Blumberg, metallurgist, Illinois Steel Co., served as Chairman of the subcommittee which handled the subject "Hardening and Tempering Tool Steels".

"Case Hardening" was handled by a committee of which T. G. Selleck, the well known authority on that subject, was chairman.

Of course, it will be realized that a detailed study of all of the above phases of heat treating could not be encompassed in the brief time of 20 evenings which is the usual term of evening courses in these Institutes, nor was this the object of this first course. Its purpose was to give to these classes, composed of hardening room workers and students, a broad vision of the science and a comprehension of the possibilities in the steel treating field. In other words, this course was calculated to create a desire for a more thorough understanding of each of the several scientific phases of the art, each of which are to be specialized upon by classes which will follow.

Before these classes were organized conditions had changed in the staffs of the Institutes mentioned and the Armour Institute had available for instructing in this course, Prof. Arthur Howe Carpenter, thus relieving the educational committees of the Chapter the tasks of presenting the subject to the classes.

Professor Carpenter, because of the previous education and experience of the members of his class, concluded that he could best serve by devoting the entire term to the metallographic study of structural changes due to heat treatment and proceeded along that line.

The Lewis Institute, a few months previous to the starting of its two classes, of about 20 each, added to its faculty Prof. John F. Keller, former-

ly professor of forging of Purdue University, Lafayette, Ind., and past president of the Steel Treating Research Society, who took charge of the forging and heat treating instruction.

Professor Keller, however, preferred to conduct the work along the plans proposed by the educational committee and in presenting the course to the classes to avail himself of the assistance of those who had prepared the texts and lectures.

Both Institutes, while possessing considerable apparatus and equipment necessary for the successful presentation of the subjects, made liberal expenditures to make their facilities complete, this outlay amounting to several thousand dollars.

Classes were started with a motion picture lecture, illustrating all phases of steel manufacture from the mining of the ore to the finished bar, this serving to arouse a keen interest in the minds of the students for that which followed.

The evolution of the popular types of pyrometers and the fundamental principles of them were thoroughly explained by lectures, lantern slides, demonstrations and by competent and comprehensive answers to class questions which brought out much of value in the nature of practical self helps in every day practice.

The microscope, its manipulation and application, together with the methods of preparing specimens was next treated by lecture, illustrations and demonstrations, which, while only scratching the surface of the subject, was a revelation to most of the students and gave them a vision of the possibilities in the study and development of the heat treating art, to which a thorough knowledge of metallography would contribute.

Instructions in the use of the pyrometer and microscope were first in the course because of almost constant reference to them in the lectures and demonstrations pertaining to the subjects which followed.

Forging was made very interesting to the classes by running two furnaces side by side on specimens of the same material one with proper heats, the other with improper heats, after which the difference in results was observed by microscope and physical tests. High heating and soaking with but little work, producing extreme grain growth; rapid heating and working over a cold core, developing slip bands and surface cracks; conversely the results of forging on a falling temperature after a high soaking heat, thus producing internal cracks and pipe; varying grain structures produced by uneven heats were also illustrated. The action and effect of sulphides and phosphides when excessive heats and light forging is done, especially when the finishing is done at a temperature above normal for forging, was clearly portrayed by specimens and micrographic slides. The baneful results of improper upsetting, edging up and cold bending were made evident by the shear lines, cracks and slip bands in samples thus mistreated.

Following the lectures and text on forging came the treatment of annealing which was considered from all angles. One feature of this deserves special mention, namely, the demonstration of the fallacy of the idea, held by some, that annealing is a "cure-all" for all the diseases in steel inherited from faulty forging.

The effects of alloys in steels was handled in a way to impress upon the student's mind the function of each of the commonly used elements and

the physical characteristics produced by varying amounts and combinations of them. Also their influences upon the critical temperature ranges as contrasted with the regular carbon diagram were demonstrated.

High carbon and high speed steels were treated by a separate text, supplemented by slides and the microscope, the same scheme of treating and mistreating samples being resorted to to carry the points home to the student.

Last, but not least interestingly and thoroughly handled was the subject of case carburizing and hardening. This was accomplished by a large collection of specimens, lectures, charts, slides, micrographs and practical packing and heating demonstrations.

Enthusiasm was maintained throughout the course and all who participated voted it a great success, many expressing themselves as having been benefited far more than they had any anticipation when they entered.

Success of the course is assigned to the co-operation of various committees and those who offered helpful suggestions while the lectures were being conducted. The success was made more complete through the generosity of several steel companies which supplied samples of their analyses and other data of value.

HOW THE PHILADELPHIA CHAPTER CONDUCTED A SUCCESSFUL MEMBERSHIP CAMPAIGN

By H. C. Knerr*

In April, 1920 the chairman of the Philadelphia Chapter received a letter from the national headquarters containing information regarding the convention to be held in Philadelphia in September and suggesting that the local chapter conduct a membership campaign for two or three hundred new members before the convention. Thus spurred to activity and since the summer months offered excellent opportunity for such work, the membership committee decided to organize a campaign.

When the committee was completely organized, one of the problems that confronted it was how to get the entire membership to work. Without the support of all those who had evinced sufficient interest to pay their dues, any campaign would have been fruitless. The first step was to divide the city and adjacent territory into five sections. Following this the available membership was divided into five groups and each placed under the leadership of an active member with an associate member as an aide. The out-of-town members and the chapter officers composed a sixth team which was responsible for all outlying territory. A bulletin was issued and sent to every member explaining the purpose and plan of the campaign. Prizes were offered for the highest and second highest individual score.

It was soon found, however, that the team plan, although plausible in theory, was cumbersome and ineffectual for several reasons. Team captains found great difficulty in maintaining contact with the members of their teams and in helping their teams work as a whole. Some of the team captains found it impossible to devote the necessary time to the work and canvassing of a specific territory by members of a team proved to be

* Metallurgist, Naval Aircraft Factory, United States Navy Yard, Philadelphia, and chairman Philadelphia Chapter membership committee.

impracticable. Individual activity of the members independent of any rules or regulations proved to be the most fruitful of results. Therefore the team plan was discarded.

At chapter meetings the scores of individual members were posted on the blackboard. This enlivened interest in the campaign and promoted a friendly and resultful spirit of competition. At intervals, letters were sent to all members reporting progress of the campaign and offering suggestions for greater results. One of these letters which proved specially effective is given below:

December 7, 1920

Dear Fellow-Member:

We have just received a definite statement from Headquarters that the Initiation Fee is waived until January 1, 1921—*only*.

This means that those who have, for diverse reasons, postponed sending in their applications for membership, and those with whom you have not as yet gotten in touch in regard to joining, will profit to the extent of $3.00 for regular members, and $10.00 for associates—real money—if they act at once—NOW.

We ask you to make this clear to all prospective members whom you have in view. The time is short. The holidays coming at the end of the month will make it shorter. (In case spare cash is also short, remember that a deposit of only $2.00 is required.) DO IT NOW.

Applications may be mailed direct to the writer, or to Mr. A. L. Collins, Engineers' Club, 1317 Spruce St,. Philadelphia. Checks should be made payable to Arthur L. Collins.

Have you enough Application Blanks?

Special: A personal chat is the surest and best way to interest a new member. But if there are some good "prospects" whom you cannot reach personally, please put their names on the enclosed return postcard and mail it without delay; also, if possible, send each of them a note, or phone him, telling him of your action.

We will write each man a letter, stating that you have recommended him for membership, explaining briefly the advantages, and inviting him to join. You will be credited with any applications so received.

If you think of more "prospects" later, send another postal. Thank you.

H. C. KNERR,
Chairman, Membership Committee, A. S. S. T.
Engineers' Club of Philadelphia,
1317 Spruce St.,
Philadelphia, Pa.

Personally addressed letters were sent to all prospects as they were proposed and recommended by the members. This letter was as follows:

....
....

Dear Sir:

One of our members, Mr. .... has recommended you for membership in the American Society for Steel Treating, and at his suggestion we take pleasure in sending you information concerning the Society and inviting you to apply for membership.

As one whose work deals with the use of steel, or with some of the many phases of its treatment, you will naturally be interested in the activities of this organization.

The American Society for Steel Treating is a new national society, created by the amalgamation of two former bodies, the Steel Treaters Research Society and the American Steel Treaters Society. Its formation is a result of the general awakening to the tremendous industrial importance of more comprehensive and accurate knowledge concerning the treatment of steel.

The purpose of the Society is educational, and includes the collection and dissemination of knowledge concerning the heat treatment of steel in its diverse forms and bearing upon processes, instruments, equipment, and methods employed in the art. A special aim is to closely unite those engaged in the practical, technical, and theoretical branches of the work.

There are now about thirty Chapters in the leading cities of the United States, and the membership is rapidly growing.

The Philadelphia Chapter holds monthly meetings at the Engineers' Club of Philadelphia, with which body it is affiliated. Papers are read, frequently illustrated by lantern slides or motion pictures and are followed by questions and discussion.

The best papers presented at the various Chapters are published in the monthly "TRANSACTIONS" of the Society, thereby keeping all members in touch with the latest advancements of the Art.

Membership in the Society (Philadelphia Chapter) includes:

(a) Identification with the only National Organization devoted solely to the Treatment of Steel.
(b) Subscription to the Transactions ($15.00 per year to nonmembers.)
(c) Free use of Employment Service Bureau.
(d) Attendance at the monthly meetings of the Philadelphia Chapter at Engineers' Club, 1317 Spruce St. Participation in papers and discussion. (Membership may be transferred to any other Chapter).
(e) Affiliation with the Engineers' Club, conveying privileges of the Club on meeting nights.
(f) Subscription to the Journal of the Engineers' Club of Philadelphia ($4.00 per year to nonmembers). (A progressive and valuable publication).

The dues, including all the above items are:

Member	$10.00	per annum
Associate	15.00	per annum
Sustaining Member	25.00	per annum

Initiation Fee (Waived until Jan. 1, 1921)

Member	3.00
Associate	10.00

See application blank for classification of membership.

An application blank is enclosed. We shall be glad to provide the necessary endorsement if you will fill out the form and mail it to the undersigned. Needless to say, this invitation is in itself a guarantee of favorable action by the Executive Committee upon your application.

IMPORTANT

The initiation fee is waived only until Jan. 1, 1921. The time is short. We cannot insure you the advantage of this saving unless favored with your prompt reply. A deposit of $2.00 should accompany application, or if you prefer, you may remit the full amount of your dues. Make check payable to Arthur L. Collins.

We hope to have the pleasure of welcoming you into the Society, and are confident that your membership would be a benefit both to yourself and to us. Trusting to have your early and favorable reply, we are

Yours very truly,

American Society for Steel Treating
Philadelphia Chapter

per ....

Secretary-Treasurer,
1317 Spruce St., Phila.

The results of the campaign which was carried on until the March meeting of the chapter were as follows:

Old members on June 1920	57
Steel Treating Research Society members at time of convention	26
New members obtained up to March 24, 1921	152
Total members on March 24, 1921	235

The contest for the prizes was closed on Dec. 31, 1920, at which time the highest scores were as follows:

	New Members	
H. J. Huester	13	First Prize $10.00
G. W. Tall	8	
G. P. Bible	8	

E. J. Gaugham	8	Second Prize	$ 5.00
H C. Knerr, Chairman	25		

Second prize was awarded to Mr. Gaugham through the withdrawal of Mr. Tall and Mr. Bible on the ground that they were associate members and had greater opportunity for obtaining new members than Mr. Gaugham.

One feature of the campaign was that one man, an active member and chairman of the membership committee, who had little opportunity of getting out to meet new men, obtained 25 new members. The real success of the campaign was due largely to the co-operation of the committee and the untiring efforts of its chairman, H. C. Knerr.

THIRD ANNUAL CONVENTION OF THE AMERICAN SOCIETY FOR STEEL TREATING, STATE FAIR GROUNDS, INDIANAPOLIS, IND., SEPT. 19-24, 1921.

General Topics

1. The Organization and Management of a Heat Treating Department.
2. Practice of Handling and Checking Materials to and from Heat Treating Department.
3. Quantity Production Methods for Forging and Heat Treating Tools.
4. Methods for Heat Treating very small Machine Parts.
5. The Heat Treatment of Sheet Steel Parts as Saws, Hack Saw Blades, etc.
6. The Artificial Seasoning of Hardened Steel.
7. Furnace Design with Reference to Fuel Economy.
8. Metallography and its Applications.
9. Comparative Study of Methods for Heating Furnaces by (a) Coal, (b) Fuel Oil, (c) Gas, (d) Electricity.

Alloy Steels

1. Topical Discussion of Alloy Steels and their Heat Treatments for Specific Purposes, as (a) Springs, (b) Gears, (c) Finishing Tools, (d) High Speed Cutting Tools, (e) Dies.
2. Practice of Ordering Tool Steel on Specifications.
3. Cutting Efficiency of High Speed Steel Which Has Received Different Methods of Hardening.
4. Die Blocks and Their Heat Treatment.

Carburizing

1. Carburizing Practice Adapted to Alloy Steel Parts.
2. Determination of Unit Cost of Carburizing Steel Parts.
3. The Efficiencies of Different Mixtures for Cyanide Hardening.
4. Practice of Cyanide Hardening.
5. The Service of Annealing Boxes Made of Different Materials.

Notice Regarding Papers

Each member of the Society should consider it a duty to carefully consider the investigations which he has made with the thought of presenting at the Annual Convention any information which will be of interest to the members of the Society. There is no better way to fulfill the spirit of our motto: ALL FOR EACH AND EACH FOR ALL.

All papers for the Indianapolis Convention should be in the hands of the Committee on or before Aug. 1, 1921.

The Meetings and Papers Committee wishes to know the topic which you decide upon. It is not necessary that it be included in the attached list of topics.

This form is for your convenience. Please fill in the necessary information and mail today.

To Chair of Meetings and Papers Committee,
H. L. Campbell, 1103 E. Huron Street, Ann Arbor, Mich.

Name .... Address..........................

Firm connected with ....

Occupational capacity ....

Subject ....

Will your paper be illustrated by lantern slides? Yes....... No.......

Suggestions ....

....

OBITUARY

Harold George Weidenthall

Harold George Weidenthal, metallurgical engineer, Cleveland, O., died on April 13. Mr. Weidenthal was born in Cleveland, March 16, 1891, was educated in the public schools, graduating from Lincoln High School in 1909 and Cornell University in 1913 with the degree of M. E. During vacations he worked at the Brown Hoisting Machinery Co., the Walworth Run Foundry Co., the Canton Rolling Mills and the Upson Nut Co. In 1913, after graduation, he went with The Lorain Steel Co., Lorain, O., as open-hearth foreman. In 1914 he joined the Upson Nut Co., Cleveland, as metallurgical engineer, leaving in 1915 to become connected with John R. Crowley Co., Detroit, as chief electric furnace melter. In 1916 he joined the Standard Chemical Co., Cannonsburg, Pa., as metallurgical engineer, but in 1917 became associated with the General Steel Co., Milwaukee, as works manager. From 1918 to 1920 he was with the James H. Herron Co., Cleveland, as vice president and chief metallurgical engineer. In 1920 he became consulting metallurgical engineer.

Mr. Weidenthal was a member of the Cleveland Engineering Society, the American Society for Testing Materials and the American Society for Steel Treating. He was a member of Board of Directors of latter society in 1919-1920.

News of the Chapters

NEW CHAPTER IN GARY

The steel interests of Gary have ever since the organization of the Society furnished a large number of members for the various local sections, and the idea was conceived by a number of the members that it would be advisable to have a local chapter established there that they might have monthly meetings and discuss problems of interest to all in the vicinity. Consequently, through the efforts of A. Hungelman, a petition of 21 signers was secured and presented to the Board of Directors asking that a chapter be granted to Gary. The application for a charter was favorably acted upon by the Board, and on March 14th a meeting of the signers was held and the following officers were elected:

Chairman—A. Hungelman, metallographist, Illinois Steel Co.
Vice Chairman—J. O. Lord, metallurgist, Illinois Steel Co.
Secy-Treas.—Carl I. Holm, metallurgist, Illinois Steel Co.
Boards of Directors:

1. W. E. Hadley, assistant general superintendent, Illinois Steel Co.
2. R. B. Lucas, superintendent wheel plant, Illinois Steel Co.
3. E. Hagadone, tool treater, wheel plant, Illinois Steel Co.
4. J. B. Monahan, superintendent rail mill, Illinois Steel Co.
5. C. J. Kennedy, engineer, American Bridge Co.

The first regular meeting was held on Wednesday, April 13, when W. H. Eisenman, National Secretary, was present and addressed those in attendance. About 125 were present at this meeting.

The excellent officers selected and the interest shown by the charter members is conclusive proof that Gary chapter has a bright and prosperous future.

ROCHESTER CHAPTER

W. B. Huther, president of the Huther Bros., Saw & Mfg. Co., gave a very interesting talk before the local chapter on the "Manufacture and Use of Saws", on April 1. Mr. Huther gave details of the various process used in making all kinds of saws, including machine work and heat treating. The meeting was held at the Rochester Hotel and was very well attended. A buffet lunch was served at the close of the meeting.

SYRACUSE CHAPTER

The local chapter held an extra meeting on March 29 at the Chamber of Commerce rooms which was addressed by C. U. Scott, president of the C. U. Scott Company, on the subject of "High Speed and Die Blocks". About 60 were in attendance and a very heated discussion followed the presentation of the paper.

BALTIMORE CHAPTER

The Baltimore chapter held a wide-awake meeting at the Engineers Club of Baltimore on Tuesday, April 19. G. W. Tall, of Leeds and Northrup Co., presented an illustrated paper on the "Hump Method of Heat Treatment". The meeting was well attended and most thoroughly enjoyed.

BOSTON CHAPTER

At the Engineers' Club, on April 12, Irving Cowdrey, instructor of mechanical engineering, Massachusetts Institute of Technology, and secretary of the local chapter, presented a paper before 50 of the members on "The What and Why of the Pyrometer". A very interesting discussion on the checking and calibration of pyrometers followed the presentation of the paper.

BUFFALO CHAPTER

C. U. Scott, president of the C. U. Scott Co., Rock Island, Ill., presented an interesting paper before the Buffalo chapter on Monday evening, March 28th, at the University Club. A dinner was served at 6:30 and the meeting at 8:00 was well attended.

DETROIT CHAPTER

On April 11, H. J. Stagg, assistant manager of Halcomb Steel Co., presented a very interesting paper before about 65 members of the local section in the Board of Commerce rooms. The paper was very well received and the members enjoyed the opportunity of meeting with Mr. Stagg, one of the National Board of Directors of the Society.

On April 28, C. M. Johnson, director of research, Park Works, Crucible Steel Co. of America, Pittsburgh, presented an interesting and instructive paper on "Resistal Steels". Mr. Johnson is thoroughly master of his subject and presented the paper in an entertaining manner. The evening proved to be very interesting and decidedly educational.

PROVIDENCE CHAPTER

On March 31 the Providence chapter of the Society had its meeting in the Providence Engineering Society rooms when Major A. E. Bellis, chief metallurgist of Springfield Armory, presented a paper on "Hardening, Quenching and Tempering of High Speed Steel". Over 80 were in attendance at this meeting and most thoroughly enjoyed Major Bellis' paper. An interesting discussion followed and was quite generally participated in by the members and guests present.

CLEVELAND CHAPTER

The Cleveland chapter has had the privilege of hearing very many prominent speakers throughout the year all of whom delivered excellent papers. Over 200 turned out Friday evening, April 22, in the Engineering Society rooms in the Statler Hotel, to honor Professor Albert Sauveur, professor of metallurgy and metallography at Harvard University. Poiessor Sauveur presented a paper on the "Dendritic Structure of Steel", which proved to contain the research done on this subject during the past two years at Harvard, and gave much interesting and enlightening information with reference to this peculiar structure. At this meeting Professor Sauveur was presented with his certificate of Honorary Membership in the Society.

CHICAGO CHAPTER

The Chicago chapter held its monthly meeting on Tuesday evening, April 12, at the City Club. Over 125 were present for dinner and for the meeting at eight o'clock, to welcome Lieut. Col. A. E. White, National President, who was guest of honor while paying his official visit to that chapter.

The meeting also served as a tribute to the first vice president of the Society, T. E. Barker, who is leaving Chicago to become associated with the Denver Rock Drill & Mfg. Co., Denver, Col. At the meeting, F. C. Lau, chairman of the local chapter, presented Mr. Barker with an electric percolator set, the gift of the members of the Chicago chapter to Mr. Barker. In Mr. Barker's response he reviewed the early history of the formation of the Society, inasmuch as he has been actively connected with it since the beginning of the Chicago chapter.

Col. White spoke impromptu on the work of the Society in general, and added his appreciation of the services of Mr. Barker in assisting in the development of the National Society.

The National Secretary, Mr. W. H. Eisenman, said a few words of Godspeed to Mr. Barker, and informed the other members of the chapter of the progress relative to the National Convention to be held in Indianapolis, Sept. 19 to 24.

Other speakers were: Mr. Nethercutt, secretary of the Western Society of Engineering; H. H. Clark, former chairman of the local chapter; Professor Keller, of Lewis Institute; A. G. Henry, first secretary of the local chapter and formerly National Secretary of the Society.

ST. LOUIS CHAPTER

Over 100 were present for dinner on April 11 at the American Hotel to greet the National president, Lieut. Col. A. E. White. The Colonel's visit was especially well received and the paper he presented was very interesting. The meeting proved to be most successful and enjoyable.

The regular March meeting was held at the American Hotel and was attended by about 75 members and guests. The speakers of the evening were G. S. Rogers, of E. F. Houghton Co., on the subject of "Quenching Mediums"; C. B. Swander, metallurgist for Wagner Electric Mfg. Co., and secretary of the St. Louis chapter, whose subject was "Hardening Drawing Dies". Walter Brown, of the Brown Tool Co., also spoke on the "Explanation of the S. A. E. Numbers".

WASHINGTON CHAPTER

Washington chapter had a very interesting and well attended meeting on Friday evening, April 22, in the auditorium of the New Interior Department Building, on the subject of "Molybdenum Steel."

The program was presented by two speakers. Dr. G. W. Sargent, president of the Molybdenum Corp. of America, spoke on "Some Features in Connection with the Development of Molybdenum Steel". Martin H. Schmid, metallurgist United Alloy Steel Co., Canton, O., spoke on "Molybdenum Steel and Its Application". Both speakers presented papers of interest and value to the designer, manufacturer, and user. An excellent discussion followed the presentation of the paper and the meeting proved to be very educational.

PITTSBURGH CHAPTER

The regular monthly meeting of the Pittsburgh chapter scheduled for Tuesday evening, April 19, was postponed due to the inability of Lieut. Col. White to be present. However, a joint meeting was held with the American Institute of Mining and Metallurgical Engineers at the Fort Pitt Hotel, on Wednesday evening, April 20. The speaker of the evening was Professor Albert Sauveur, who presented a paper on the "Dendritic Structure of Steel".

CINCINNATI CHAPTER

The April meeting of the Cincinnati chapter was held on April 1 at the Ohio Mechanics Institute, and was addressed by A. J. Wilson, of Warner Gear Co., Muncie, Ind., on the subject of "Making the Most Out of High Speed Steel". Over 75 were in attendance at this meeting and the discussion brought out by Mr. Wilson's paper was one of the most interesting that has ever been produced in this chapter. A buffet lunch at the close of the meeting served as a means of furthering the acquaintance of all the Cincinnati members.

On Friday evening, April 29th, at the R. K. LeBlond Machine Tool Co.'s plant, C. S. Gordon, consulting engineer, presented a paper on "Pyrometers and Their Application". Mr. Gordon is thoroughly familiar with this subject and his paper was well presented.

SCHENECTADY CHAPTER

The Schenectady chapter held its regular monthly meeting in the Civil Engineering Building of Union College on March 30 when C. U. Scott, president of the C. U. Scott Co., presented the paper of the evening, to over 75 members and guests in attendance.

Mr. George Smith, for several years considered the champion Indian Club swinger of Canada, presented an act of swinging illuminated clubs. Altogether the evening proved very enjoyable.

MILWAUKEE CHAPTER

The April meeting of the Milwaukee chapter was held at the Medford Hotel on April 14, when R. W. Burleigh, metallurgist of the U. S. Ball Bearing Co., presented a paper on "Some Fundamentals of Iron and Carbon Diagram". Some 65 members were in attendance and heard Mr. Burleigh's paper.

SPRINGFIELD CHAPTER

The April meeting of the Springfield chapter was held in the Chamber of Commerce Building on Friday evening, April 15. The speaker of the evening was Prof. John H. Nelson, metallurgist of Wyman-Gordon Co. Inasmuch as the Wyman-Gordon Co. is one of the largest producers of automobile crankshafts and it is Mr. Nelson's work to maintain their high standard because he is in control of the laboratory, the paper was, of course, very practical, interesting and instructive. The title was "The Forging and Heat Treating of Alloy Steels".

A question box was instituted at the last meeting by which questions relating to the subject of the previous meeting were submitted to the secretary and answered at the meeting on April 15.

LEHIGH VALLEY CHAPTER

Lehigh Valley chapter held one of its best meetings on April 26 in the Assembly Room of the Public Library of Easton. The paper was presented by W. R. Shimer, sales metallurgist of the Bethlehem Steel Co., who spoke on the "Manufacture of Steel from Raw Material to Finished Product". Mr. Shimer included in his paper, remarks on the heat treatment of steel and fatigue failure. The entire talk was illustrated by a number of illustrated slides. A nominating committee was appointed to nominate officers and executive committee for the following year.

HARTFORD CHAPTER

The April meeting of the Hartford chapter was held on the 14th at the Hartford Y. M. C. A. Assembly Room. The subject of the evening was of especial interest to all, and was presented by Lester Lanning, of the New Departure Mfg. Co., on "Open Hearth Furnaces", while C. B. Collingwood, superintendent of the Stanley Works, New Britain, Conn., spoke with reference to "Open Hearth Furnaces". The usual discussion on the elements and their effect on heat treatment was presented, the element vanadium occupying the center of attention. The discussion of shop problems was also continued. The committee appointed to consider the "Nomenclature of Heat Treating Terms" also reported.

NEW HAVEN CHAPTER

The New Haven chapter is fast making progress so that it soon will be recognized as one of the largest chapters in the East, not so much from a point of members, as from attendance at meetings.

Over 200 were present to see a practical demonstration made by Major A. E. Bellis, chief metallurgist at Springfield Armory, in hardening "High Speed Steel by the Salts Bath Method", in the heat treating department of the Geometric Tool Co. The use of the laboratory at the Geometric Tool Co. was obtained through the courtesy of Mr. Adt, president of this concern. The method demonstrated was similar to the one used at the Springfield Armory and deeply interested all technical and practical men. At the close of the demonstration, those present were the guests of the Geometric Tool Co., who presented some special moving pictures and very pleasing refreshments.

The second April meeting of the New Haven chapter was held in Waterbury at the plant of the Bristol Co., when W. H. Brown, president of the company, by the use of talking moving pictures, gave an illustrated talk on some of the latest pyrometer models and automatic pyrometer temperature regulators. In addition, Mr. Brown showed some of the latest developments in the field of talking moving pictures. Quite a large number of members from the surrounding towns and Waterbury particularly, were in attendance at this meeting.

INDIANAPOLIS CHAPTER

Indianapolis chapter had a very interesting meeting on April 12 when 75 were present at the meeting. A. L. Cramp, of Lafayette Motors, spoke on the subject of "Hardening Cam Shafts". W. R. Chapin, of E. C. Atkins Co., gave a talk on "Hardening High Speed". Both talks were very instructive and were followed by lively discussions.

The Nominating Committee reported at this meeting, selecting A. L. Cramp as chairman, and Paul Smith as secretary-treasurer. This report was accepted and election will be held at the May meeting.

The May meeting of the Indianapolis chapter was held in the Chamber of Commerce rooms on Monday, May 2. The annual election of officers took place at this meeting, after which, W. L. Patterson, of Bausch & Lomb Optical Co., gave a talk on "The Optics of Metallography". The talk was illustrated by lantern slides and proved very interesting and instructive to the large number present.

At a volunteer meeting of the members of the Indianapolis chapter for volunteers to serve on committees for the Convention, 75 local men responded and helped to get plans and activities under way to make the Convention a success.

NEW MEMBERS' ADDRESSES OF THE AMERICAN SOCIETY FOR STEEL TREATING

EXPLANATION OF ABBREVIATIONS. M represents Member; A represents Associate Member; S represents Sustaining Member; J. represents Junior Member, and Sb represents Subscribing Member. The figure following the letter shows the month in which the membership became effective.

ABBOT, R. R. (M-3), Met., Peerless Motor Car Co., Cleveland, Ohio.

ALLEN, R. D. (M-3), Asst. in physical testing Lab., Studebaker Corp., South Bend, Ind.

ANDERSON, Geo. R. (M-4), Fore., 1041 Goodlet Ave., Indianapolis, Ind.

ARNOLD, Mowry A. (M-3), G. M. C. Truck Co., Pontiac, Mich.

AURAND, Walter (M-2), R. Wallace & Sons Mfg. Co., Wallingford, Conn.

AUSTIN, J. H., Asst. Wks. Mgr., Goodman Mfg. Co., *for mail*, care company, 4834 S. Halstead St., Chicago, member, to April 1922.

BARACH, Samuel (M-3), Met., 1439 T. St., N. W., Tuxedo Apt. 308, Washington, D. C.

BARLOW, J. E., Inspector, Goodman Mfg. Co., *for mail*, 747 W. 55th Place, Chicago, Ill., member, to April 1922.

BARNETT, J. W. (A-3), Sales., Crucible Steel Co. of Amer., 1228 Callowhill St., Philadelphia, Pa.

BARRY, R. L., Engineering Dept., Goodman Mfg. Co., *for mail*, care company, 4834 S. Halstead St., member, to April 1922.

BECKER, Chas. R. (M-4), 631 Canton, Detroit, Mich.

BEGLEY, J. P., Chief Chemist, American Steel Foundries, *for mail*, 1448 East 72nd Place, Chicago, Ill., member, to March 1922.

BELL, Wm. H. (A-3), Sales, 2281 Scranton Rd., Cleveland, Ohio.

BERGGREEN, P. H. (M-5), Met., Room 281, Bureau of Mines, Pittsburgh, Pa.

BERLINER, J. F. T. (Jr.-3), Lab. Asst., 1471 Irving St., N. W., Washington, D. C.

BERRY, Geo. D., Inspector, International Harv. Co., Chicago, *for mail*, 6556 Cottage Grove Ave., Chicago, member, to March 1922.

BERRYMAN, H. H., Mach. Shop Foreman, Pheoll Mfg. Co., Chicago, Ill., *for mail*, as above, member, to April 1922.

BIHLMAN, Victor W. (M-3), Met., 36 Maple St., Springfield, Mass.

BJORSETH, K. E. (M-4), 10 W. Huron St., Chicago, Ill.

BLACKWOOD, Geo. E. (M-4), Tool Hardener, 8841 Monica, Detroit, Mich.

BODIN, George, Designer, Goodman Mfg. Co., *for mail*, 7916 S. Carpenter St., Chicago, member, to April 1922.

BRADFORD, J. F. (M-3), Sales., 1916 West Blvd., Cleveland, Ohio.

BROWN, James B. (M-3), 18 Washington St., Armour Park, S. Charleston, W. Va

BURROUGHS, J. T. (A-3), Sales., 3063 West Blvd., Cleveland, Ohio.

CASE, L. B. (M-3), 2261 Garland, Detroit, Mich.

CHAVEAS, Nicholas (M-3), Asst. Fore., 2264 N. 17th St., Philadelphia, Pa.

CHELIUS, E. J., Asst. Supt., Elec. Furnace Dept., Illinois Steel Co., *for mail*, Station No. 41, Illinois Steel Co., South Chicago, Ill., member, to April 1922.

COALE, J. D., Chief Inspector, Ingalls Shepard Division, Wyman Gordon Co., Harvey, Ill., *for mail*, 14608 Green St., Harvey, Illinois, member, to March 1922.

COPE, Lorenzo S. (M-2), 920 Mary St., Ann Arbor, Mich.

CRANE, Lewis Debb (M-4), Chem., 306 Waverly Ave., Syracuse, N. Y.

DARFLER, R. W., Asst. Foreman, Heat Treat. Dept., Ingalls Shep. Div., Wyman Gordon Co., Harvey, Ill., *for mail*, 209 Lewis Street, Blue Island, Ill., member, to March 1922.

DELAPOTTERIE, Harry (M-3), Eng., Falls Rivet Co., Kent, Ohio.

DERRY, A. T. (M-3), Asst. Phys., 3805 Yuma St., N. W., Washington, D. C.
DEVINE, H. A., Student, Lewis Institute, Chicago, *for mail,* 218 East 55th Place, Chicago, member, to March 1922.
DONALD, Gus, Chief Chemist, Ingalls Shepard, as above, *for mail,* 861 Summit Ave., Blue Island, Ill., member, to March 1922.
DUGRAY, F. S. (A-4), Res. Mgr., J. B. Ford Co., 603 Merchants Bk Bldg., Indianapolis, Ind.
DWALL, Henry (M-4), Care Weidley Motors Co., Georgia & Shelby Sts., Indianapolis, Ind.
EDSON, Charles S. (A-12), 4873 Edmonton, Detroit, Mich.
EMWECHTER, Norman (M-3), 512 Commerce St., Philadelphia, Pa.
EPSTEIN, Samuel (M-3), Asst. Phys., 925 North St., N. W., Washington, D. C.
ESSELTINE, A. B., Designer, Goodman Mfg. Co., *for mail,* 2026 N. California Ave., Chicago, member, to April 1922.
ETTER, Paul A. (M-3), 1736 Johnson St., Philadelphia, Pa.
EVERIST, L. E., Foreman Blacksmith, Goodman Mfg. Co., *for mail,* care company, 4834 S. Halstead St., Chicago, Ill., member, to April 1922.
FALLON, Thomas D. (M-3), Eng. of Tests, Camden Forge Co., Camden, N. J.
FARNSWORTH, Grover (M-3) Oakland Motor Car Co., Pontiac, Mich.
FINNERAN, E. J. (M-3), Naval Gun Factory, Washington, D. C.
FRANCE, Ramon D. (M13), Met., 405 M. Street, N. E., Washington, D. C.
GANCZ, Victor, Tool Room Foreman, Goodman Mfg. Co., *for mail,* 4512 N. Central Ave., Chicago, Ill., member, to April 1922.
GARDNER, Samuel L. (M-3), Insp. of Materials, 1335 C. Street, N. E., Washington, D. C.
GOETSCH, John R. (M-1), 226 Wells St., Wauwatosa, Wis.
GROH, Paul, Production Mgr., Pheoll Mfg. Co., *for mail,* care firm, 5700 Roosevelt Road, Chicago, Ill., member, to April 1922.
GRUDA, J. E. (M-4), Allis Chalmers Mfg. Co., West Allis, Wis.
HAMPP, Wm. (M-3), International Silver Co., Wallingford, Conn.
HANSON, G. A. (M-3), Mgr., 1636 South Broad St., Philadelphia, Pa.
HARS, David P. (A-4), Hotel Stevenson, 46 Davenport, Detroit, Mich.
HAWKINS, M. I. (M-3), Mech. Supt., Naval Aircraft Factory, Philadelphia, Pa.
HEASLETT, R. C. (M-4), Wheeling Mold & Foundry Co., Wheeling, W. Va.
HEISE, R. H. (M-3), Asst. Supt., General Metal Products Co., 2400 S. Jefferson Ave., St. Louis, Missouri.
HILLER, F. B. (M-4), 185 Fairview Place, Hartford, Conn.
HISLOP, Thos. W. Jr. (M-4), 2410 11th Ave., Watervliet, N. Y.
HORNER, W. C. (A-4), Sec Treas. Deeds Commercial Laboratory, 2150 Montcalm St., Indianapolis, Ind.
HOGG, James M. (M-4), Crompton & Knowles Loom Works, Providence, R. I.
HOWLAND, J. A., V. P., A. O. Blaich Co., *for mail,* 635 Waveland Ave., Chicago, Ill., associate, to April 1922.
HURCOMB, F. A. (M-3), Plant No. 2 Studebaker Corp., South Bend, Ind.
HUTCHINGS, A. E., Inspector, Goodman Mfg. Co., *for mail,* 4138 Ellis Ave., Chicago, Ill., member, to April, to April 1922.
HYDE, F. R., Master Mechanic, Goodman Mfg. Co., *for mail,* care company, 4834 S. Halstead Street, Chicago, member, to April 1922.
IRVINE, A. S., Supt. Finishing Division, Ingalls Shepard Div., Wyman Gordon Co., Harvey, Illinois, *for mail,* care company, member, to March 1922.
JENKS, W. E. (M-3), Teacher, 2166 De Forest Rd., Cleveland, Ohio.

JOHNSON, H. A., Plant Engineer, Ingalls Shepard Division, Wyman Gordon Co., Harvey, Illinois, *for mail,* care company, member, to March 1922.

JOHNSTON, R. L. (M-3), Met., Acme Die Casting Corp., Bush Terminal Bldg., Brooklyn, N. Y.

JOHNSON, W. G. (M-3), Asst. Phys., 1811 Wyoming Ave., Apt. 32, Washington, D. C.

JONES, J. H. (M-4), 83 Main St., Bristol, Conn.

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KERSLAKE, R. E. (M-3), Met., Stop 7, Euclid, Ohio.

KIETH, John (M-3), Met., 30 Fountain St., Holyoke, Mass.

KMAN, George, Foreman, Hardening Dept., Goodman Mfg. Co., *for mail,* 855 W. 51st Place., Chicago, Ill., member, to April 1922.

KOEHLER, W. W., Chemist, Goodman Mfg. Co., *for mail,* 3115 Osgood Street, Chicago, Ill., member, to April 1922.

KOKESCH, E., Division Supt., Goodman Mfg. Co., *for mail,* 8513 S. Morgan Street, Chicago, Ill., member, to April 1922.

KRYNITSKY, A. L. (M-3), Asst. Phys., P. O. Box 258, Mt. Ranier, Md.

LAMB, Lester S. (A-3), Sales., Halcomb Steel Co., 633 Arch Street, Philadelphia, Pa.

LARCHER, A. J., Asst. Supt., Ingalls Shepard Division, Wyman Gordon Co., Harvey, Illinois, *for mail,* 15235 Center Ave., Harvey, Illinois, member March 1922.

LIVINGSTON, Eddie (M-4), Hammersmith, 1208 S. 7th St., St. Louis, Missouri.

MACGREGOR, Chas. (M-3), Toolmaker, 1106 Frankford Ave., Philadelphia, Pa.

MACINNES, R. G. (M-3), Met., 6206 Fir Ave., Cleveland, Ohio.

MALONEY, Malcolm (Jr.-4), 120 10th St., Milwaukee, Wis.

MANCEL, J. J., Chief Inspector, International Harv. Co., Chicago, *for mail,* 416 W. 101st Place., Chicago, member, to March 1922.

MARTIN, L. A., Student, Lewis Institute, *for mail,* 218 East 55th Place, Chicago, Ill., member, to April 1922.

MAYER, C. W. (A-4), Mgr., 3532 Winthrop Ave., Indianapolis, Ind.

MCCADIE, J. H. (M-4), National Twist Drill & Tool Co., Detroit, Mich.

MCCULLOUGH, W. T., Chief Draftsman, Goodman Mfg. Co., *for mail,* 8112 Clyde Ave., Chicago, Ill., member, to April 1922.

MCKEE, W. GERARD (M-12), Asst. Met., Brown Lipe Chapin Co., Syracuse, N. Y.

MENGER, L. A. (M-4), LaFayette Motors Co., Indianapolis, Ind.

MIELKE, M. H., Asst. Foreman, Heat Treat. Dept., Ingalls Shep. Div., Wyman Gordon Co., Harvey, Ill., *for mail,* 590 Vermont St., Blue Island, Ill., member to March 1922.

MILLARD, F. G., Ingalls Shepard Division, Wyman Gordon Co., *for mail,* 15412 Center St., Harvey, Illinois, member, to March 1922.

MILLER, B. B. (M-3), 5821 Pennsylvania Ave., Detroit, Mich.

MILLER, H. B. (M-4), Fore., 236 Ricking St., Indianapolis, Ind.

MOHR, Edwin J. (M-1), 1903 Chambers St., Milwaukee, Wis.

MOORE, J. W. (A-4), 1404 Oliver Bldg., Pittsburgh, Pa.

MYERS, Lawrence E. (M-4), Prod. Clerk, 1441 W. 27th St., Indianapolis, Ind.

NAIR, F. N., Supt. Heat Treating and Cold Drawing Dept., Interstate Iron & Steel Co., East Chicago, Ind., *for mail,* care company, member to March 1922.

NEWBOLD, L. T. (Jr.-3), Junior Aid, 1853 St. N. W., Washington, D. C.

NEWCOMB, E. S. (A-3), Sales., 1462 E. 133rd St., Cleveland, Ohio.

NICEWANDER, Edgar F. (M-4), Fore., Indianapolis Tool & Mfg. Co., 205 W. South St., Indianapolis, Ind.

NIGH, J. D., The Western Foundry Co., *for mail,* 4249 Drexel Blvd., Chicago, Ill., member, to April 1922.

NOYES, L. C., Engineering Dept., Union Drop Forge Co., 1746 N. Kostner Ave., Chicago, Ill., *for mail*, care company, member, to March 1922.

NUGENT, John (M-3), Asst. Fore. Heat Treat. Dept., 604 E. South St., South Bend, Ind.

PELOT, J. H. (M-3), 10 West Church St., Bethlehem, Pa.

PERRY, Don. S. (M-3), General Motors Lab. Grand Blvd., Detroit, Mich.

PHILIPS, S. E. (S-3), Spencer Turbine Co., Hartford, Conn.

PIERCE, Fred (M-4), Treas., 2801 LaSalle St., St. Louis, Mo.

POTTS, Chas. W. (S-3), Mgr. Tool Steel Dept., 316 North Third St., Philadelphia, Pa.

PYNE, James E. (M-4), Heat Treater, Diamond Alloy Tool Co., 4958 Suburban Tracks, St. Louis, Mo.

QUICK, G. W. (M-3), Asst. Physicist, Bureau of Standards, Washington, D. C.

RAFFEL, W. F., Owner, W. F. Raffel Co., Diemakers, *for mail,* 2319 N. Kenneth Ave., Chicago, Ill., member, to October 1922.

RAYNOR, H. L. (A-4), Asst. Mgr., Crucible Steel Co., 437 S. Illinois St., Indianapolis, Ind.

REDDERSON, E. W., Asst. Chief Draftsman, Amer. Car & Fdry. Co., *for mail*, 6405 S. Wood St., Chicago, Ill., member, to April 1922.

REIFSNYDER, Chas. (M-3), Fore. Annealing room, 3408 Reach St., Philadelphia, Pa.

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ROBERTS, L. J. (M-3), 1287 Military Ave., Detroit, Mich.

ROGERS, George, Tool Room Foreman, Pheoll Mfg. Co., *for mail,* as above, member, to April 1922.

ROSS, David N. (M-3), Pres., 21 W. South St., Indianapolis, Ind.

ROWE, Harry E. (A-3), Sales., Midvale Steel & Ordnance Co., Widener Bldg., Philadelphia, Pa.

ROWSEY, T. A., Division Supt., Goodman Mfg. Co., *for mail*, 8529 S. Morgan St., Chicago, Ill., member, to April 1922.

ROYEK, M. J., Miehle P. P. & Mfg. Co., Chicago, *for mail*, 1515 W. Monroe St., Chicago, Ill., member, to March 1922.

RUH, Edmund J. (M-3), Research Asst.,, 2515 Cliffhouse Place,, N. W., Washington, D. C.

SACHLEBEN, E. H. (A-4), Sales., 1517 Olive Street, St. Louis, Missouri.

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SCHWANTES, E. J., Chemist, Gulich Henderson Co., *for mail,* care company, 431 South Dearborn Street, Chicago, Ill., member, to April 1922.

SCHWEITZER, Wm. C. (M-4), Asst. Supt., 358 Whittier Ave., Syracuse, N. Y.

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SHAGALOFF, Samuel (M-3), Asst. Prod. Mgr., Studebaker Corp., South Bend, Ind.

SHAW, Wm. C. (M-3), Pyrometer Mgr., 1010 Quimby St., South Bend, Ind.

SHEPARD, C. C. Jr., Foreman Straightening Dept., Ingalls Shep. Div., Wyman Gordon Co., Harvey, Illinois. *for mail,* care company, member, to March 1922.

SHERMER, N. H. (M-4), Met., 96 St. James St., St. Catharines Ont., Detroit, Mich

SILLERS, Fred (Jr.-3), Lab. Asst., Bureau of Standards, Washington, D. C.

SINCLAIR, C. E. (A-3), Sales., The Betz-Pierce Co., Cleveland, Ohio.

SLAUGHTER, Roy (A-3), Sales., Crucible Steel Co., 437 S. Illinois St., Indianapolis.

SMART, C. F., Metallurgist, Wyman Gordon Co., Harvey, Illinois, *for mail*, care company, member, to March 1922.

SMITH, R. Robert (M-4), Met., Robert H. Hassler, Ind., 1535 Naomi St., Indianapolis, Ind.

SKAROUPKA, Thomas (M-3), Heat Treater, 3626 E. 104th St., Cleveland, Ohio.

SVESHNIKOFF, Waldemar De, (M-3), Asst. Physicist, Bureau of Standards, Washington, D. C.

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THOMAS, C. W. (M-4), 508 North Hiland Ave., Pittsburgh, Pa.

TISDALE, N. F. (M-3), Met., 11 St. James Ave., Springfield, Mass.

TRAUTMAN, H. A. (M-4), Heat Treater, 2884 Noble Road, Cleveland Heights, O.

TUCKER, W. L., Chief Chemist, Pettibone Mulliken Co., *for mail*, 606 N. Pine Ave., Chicago, Ill.

VANNICK, J. S. (M-3), Research Oper., 2034 "F" Street, N. W., Washington, D. C.

VIGEANT, Oscar (M-4), Hemphill Mfg. Co., Clay St., Pawtucket, R. I.

VOIGT, J. S. (M-4), Plant No. 3, Timken Detroit, Axle, Detroit, Mich.
Ind.

WAARICH, O. W., Hardener, Pheoll Mfg. Co., Chicago, Ill., *for mail*, 3758 Palmer St., member, to March 1922.

WAGSTAFFE, T., Chief Inspector, Goodman Mfg. Co., *for mail*, 6623 S. Winchester Ave., Chicago, Ill., member, to April 1922.

WALROTH MFG. CO. (S-4), First & O Sts., Boston, Mass.

WATTS, A. W., Asst. Metallurgist, A. Finkl & Sons, *for mail*, 2257 Argyle Street, Chicago, Ill., member, to April 1922.

WHEELER, F. G., Mech. Eng., Miehle P. P. & Mfg. Co., Chicago, *for mail*, care company, 1953 Hastings St., Chicago, Ill., member, to March 1922.

WILKINS, Chas., Heat Treater, Doehler Die Castings Co., *for mail*, 6436 Blackstone Ave., Chicago, Ill., member, to March 1922.

WILLIS, Rose E. (A-4), 1401 David Whitney Bldg., Detroit, Mich.

WILSON, Robt. W. (M-4), Vulcan Motor Axle Co., Detroit, Mich.

WOLF, Paul, Asst. Foreman, Heat Treating Dept., Ingalls Shep. Div., Wyman Gordon Co., Harvey, Illinois, *for mail*, 21 Broadway, Blue Island, Illinois, member, to March 1922.

WOLFE, H. S. (M-3), 726 Pembroke Road, Bethlehem, Pa.

WOOD, Harold F., Chief Metallurgist, Ingalls Shepard Division, Wyman Gordon Co., Harvey, Illinois, *for mail*, 6745 Ridgeland Ave., Chicago, Ill., member, to March 1922.

WOODS, Noble (M-4), Fur. Mgr., Indianapolis Tool & Mfg. Co., 205 W. South St., Indianapolis, Ind.

ZENKERE, K. D., Salesman, Vanadium Alloys Steel Co., Chicago, Ill., *for mail*, 5555 Blackstone Ave., Chicago, associate, to March 1922.

CHANGES OF ADDRESS

ARTHUR, Walter (Member) Chemist & Met., Haynes Auto Co., Kokomo, Ind., changed to 600 W. Walnut Street, Kokomo, Ind.

BANKS, R. C. (Member) Asst. Met., Maxwell Motor Car Co., Detroit, Mich., and *for mail*, 521 Rhons Ave., Detroit, Mich., changed to 5113 Rhons Ave., Detroit, Michigan.

BARKER, T. E. (Member) Production Mgr., Miehle Printing Press & Mfg. Co., 14th and Robey Sts., Chicago, Ill., and *for mail*, 2435 N. Albany Ave., Chicago, Ill., changed to Denver Rock Drill & Mfg. Co., Denver, Colorado.

BEEARS, Byron (Member) 401 N. Street, Reading, Pa., changed to 401 North 10th St., Reading, Pa.

BOOTH, Wilfred E. (Associate) 173 Farmington Ave., Waterbury, Conn., changed to The Foxboro Co., Foxboro, Mass.

BOURG, Joseph N. (Associate) Secy., Park Chemical Co., 29 Lovett St., Detroit, Michigan, changed to 3467 Lovett Street, Detroit, Michigan, and *for mail*, 296 Lawrence Ave., Detroit Michigan.

BURLEIGH, R. W. (Member) Metallurgist, U. S. Ball Bearing Co., Palmer & Kolmar Ave., Chicago, Illinois, changed to 5419 W. Cortez St., Chicago, Illinois.

CHILES, George S. (Member) Mechanical Engineer, American Steel Foundries, 332 South Michigan Ave., Chicago, Ill., changed to 4304 Lake Park Ave., Chicago, Ill.

CLARK, Reginald (Member) Asst. Supt., G. H. Williams & Co., Buffalo, N. Y., and *for mail*, 221 N. Park Ave., Buffalo, N. Y., changed to 175 Norwalk Ave., Buffalo, N. Y.

COLES, George T. (Member) Foreman, Heat Treat. Dept., H. Mueller Mfg. Co., Decatur, Illinois, and *for mail*, 1230 N. Edward St., Decatur, Illinois, changed to 1536 N. Main Street, Decatur, Illinois.

COPELAND, C. W. (Member) Metallurgist, Timken Roller Bearing Co., Detroit, Michigan, changed to Timken-Detroit Axle Co., Waterloo Ave., Plant No. 3, Detroit, Michigan.

DAWE, C. N. (Member) Met. Engr., Studebaker of Corp., Detroit, Michigan, and *for mail*, 730 Longellow Ave., Detroit, Michigan, changed to 2426 Longellow Ave., Detroit, Michigan.

DEVINE, Harry A. (Member) 225 N. Court Street, Rockford, Illinois, changed to 2011 W. Adams Street, Chicago, Illinois.

DOBLE, W. A. (Member) *for mail*, 637 Call Bldg., San Francisco, Calif., changed to 714 Harrison Street, San Francisco, Calif.

EDINGER, John J. (Member) Tool Hardener, Brown Lipe Chapin Co., Syracuse, N. Y., and *for mail*, 131 Oakwood Ave., Syracuse, N. Y., changed to 435 Burnet Ave., Syracuse, N. Y.

EVES, A. P. (Member) Chemist, International Harvester Co., 6224 Eberhart Ave., charged to 3445 Irvine Ave., Berwyn, Illinois.

FAIRFIELD, J. A. (Associate) Secy. Modern Equipment Co., Taunton, Mass., changed to P. O. Box 415, Foxboro, Mass.

FITZGERALD, J. J. (Member) Asst. Metallurgist, Maxwell Motor Co., Detroit, Michigan, and *for mail*, 254 Connecticut Ave., Detroit, Michigan, changed to 231 California Ave., Detroit, Michigan.

GAROVE, Arthur S. (Member) Forge Foreman, American Forge & Machine Co., Detroit, Michigan, and *for mail* 344 Newport Ave., Detroit, Michigan, changed to 402 Chandler Ave., Johnstown, Pa.

HAGGERTY, A. T. (Member) Metallurgist, General Motors Laboratory, 1623 E. Grand Boulevard, Detroit, Michigan, changed to Central Gear Co., Detroit, Michigan.

HEATH, W. E. (Member) Foreman, International Harvester Co., 10902 Vernon Ave., Chicago, Ill., changed to 11315 Perry Ave., Pullman Station, Chicago, Illinois.

HENNINGER, Russel B. (Member) Foreman, Detroit, Gear & Machine Co., 1361 Berwick Ave., Detroit, Michigan, changed to 5449 Berwick Ave., Detroit, Michigan.

HOVEN, J. R. (Member) Ch. Chemist, 3200 29th Ave., S. Minneapolis, Minn., changed to 823 Washington Ave., S. E. Minneapolis, Minn.

JONES, John D. (Associate) United Steel Co., 912 Ford Bldg., Detroit, Michigan, changed to 518 Fórd Building, Detroit, Michigan.

KELLEY, J. W. (Associate) 803 W. Superior Ave., Cleveland, Ohio, changed to 1111 W. Superior Ave., Cleveland, Ohio.

KIMBERLY, Silas A. (Member) Chemist, 2518 Midland Ave., Syracuse, N. Y., changed to 10 Swift Street, Auburn, N. Y.

LINDQUIST, Birger W. (Member) Supt., Vixson Mfg. Co., 1098 St. Clair Ave., Detroit, Michigan, changed to 4780 St. Clair Ave., Detroit, Michigan.

MADSEN, P. C. (Member) 4515 9th Street, Rock Island, Illinois, changed to Granda, Minnesota.

MAIN, Walter C. (Member) Metallurgist, Carnegie Steel Co., Farrell, Pa., changed to 10600 Euclid Ave., Cleveland, Ohio.

MILLER, Joseph (Member) 215 Begole Street, Detroit, Michigan, changed to 6399 Begole Street, Detroit, Michigan.

MULL, E. K. (Member) 114 N. Second St., Jeannette, Pa., changed to 107 W. Seventh St., Plainfield, N. J.

PERRY, Clyde R. (Member) Consulting Metallurgist, 30 Church Street, New York City, changed to 349 Wethersfield Ave., Hartford, Conn.

PETERSON, Walter C. (Member) Supervisor of Materials, Packard Motor Car Co., Detroit, Michigan, changed to 5174 Parker Ave., Detroit, Michigan.

PFEIFER, Carl B. (Associate) Salesman, *for mail,* 1723 Lafayette Blvd., Detroit, Michigan, changed to 1594 Pennsylvania Ave., Apt. No. 14, Berwick, Detroit, Michigan.

PURDON, Henry (Member) *for mail,* 632 Dickinson Street, Springfield, Mass., changed to 100 Westmoreland Ave., Longmeadow, Mass.

ROBERTS, Edw. E. (Member) Supt., New England Metallurgical Corp., 9 Alger St., Boston, Mass., and *for mail,* 131 Magazine Street, Cambridge, Mass., changed to 9 Alger Street, South Boston, Mass.

ROSE, C. B. (Member) Moline Plow Co., Moline, Ill., changed to 785 20th Ave., East Moline, Illinois.

ROTH, Ed. B. (Member) Pres. & Mgr., Simplex Sterling Gear Co., 751 Euclid Ave., St. Louis, Mo., changed to 5163 Gates Ave., St. Louis, Mo.

SHELDON, A. J. (Member) Engineer, American Rolling Mill Co., Middletown, Ohio, changed to 707 Yankee Road, Middletown, Ohio.

SKOOG, Carl F. (Member) Foreman, Studebaker Corp., Plant No. 2, South Bend, Ind., and *for mail,* 317 E. Broadway, South Bend, Ind., changed to 711 E. Harvey Street, South Bend, Ind.

SOWDER, Stanley (Member) Metallurgist, American Twist Drill Co., 70 Davenport Street, Detroit, Michigan, changed to 100 Davenport Street, Detroit, Michigan.

STANTON, R. F. V. (Member) Engr., *for mail,* 282 Laurel Street, Hartford, Conn changed to 33 Hamilton Street, Hartford, Conn.

SWANBERG, Gus (Member) Supt. L. P. Halliday Co., Streator, Ill., and *for mail,* 116 10th Street, Streator, Ill., changed to Gen'l. Dely., Decatur, Illinois.

TREADWAY, Alfred A. (Member) 146 Glynn Ct., Detroit, Michigan, changed to 710 Glynn Ct., Detroit, Michigan.

WILKINSON, H. P. (Member) Chemist, DeVibbie's Mfg. Co., Toledo, Ohio, and *for mail,* 1117 Horace, Toledo, Ohio, changed to 232, 21st Street, Toledo, Ohio.

WILLIAMS, Dean R. (Associate) Pardner, Williams & Holff Co., 460 Webster Place, Milwaukee, Wis., changed to 262 Palace Theatre Bldg., Milwaukee, Wis.

WILLIAMS, R. H. (Member) Supt., Arkell & Douglas, Inc., 44 Whitehall St., New York City, changed to Sidney Williams & Co., Constitution Rd., Dulwich Hill, Australia.

WILLIAMS, R. L. (Associate) Dist. Mgr., Crucible Steel Co. of America, 475 W. Lafayette Blvd., Detroit, Michigan, changed to 1723 Lafayette Blvd., Detroit, Michigan.

ZONKER, L. W. (Member) Metallurgist, Mitchell Motor Car Co., 1436 Quincy Ave., Racine, Wisconsin, changed to 822 Belmont Ave., Racine, Wisconsin.

MAIL RETURNED

BROWN, N. E., Box 155, Los Angeles, Cal.
CLARK, G. W., 165 Main St., W. Springfield, Mass.
VERICH, A. L., Davenport Locomotive Works, Davenport, Iowa.
WICKSTROM, John, 3042 Snelling Ave., Minneapolis, Minn.

Commercial Items of Interest

D. K. Bullens, well known author of "Steel and Its Heat Treatment," has organized a company located in Philadelphia, to do heat treating work and also to act as consulting engineers, making investigations and reports in addition to commercial heat treating.

The plant and offices are located at 909-911 W. Tioga street. Mr. Bullens is president and treasurer of the firm, and associated with him are W. S. Murphy, as vice president, and F. D. Metz, as secretary.

One of the novel features established by this progressive firm is the introduction of a co-operative service whereby for a small monthly retainer the firm holds itself in readiness to offer advice and to act in a consulting capacity for any firm needing such service.

Walter F. Graham has resigned as metallurgist with the Spicer Manufacturing Co., Plainfield, N. J., and is now associated with the Henry Souther Engineering Co., consulting, metallurgical and inspecting engineers, Hartford, Conn. Mr. Graham was formerly associated with the late Henry Souther as metallurgist for the Standard Roller Bearing Co., and subsequently with the Ferro Foundry & Machine Co., and the Ingersoll-Rand Co., which experience is particularly fitting for the service rendered by the metallurgical department of the Henry Souther Engineering Co.

Announcement has been made of the organization of the Engineers' Club of the Lehigh Valley during the early part of February. The club issued its first 4-page bulletin on March 15 giving the details of organization. The officers elected are as follows: R. P. Hutchinson, president Bethlehem Fabricators, Bethlehem, Pa., president; J. Madison Porter, consulting engineer, Easton, Pa., and J. S. Wise Jr., Pennsylvania Power & Power Co., Allentown, Pa., vice presidents; and T. E. Butterfield, Lehigh University, Bethlehem, Pa., secretary-treasurer. J. E. Halking, Ingersoll-Rand Co., Phillipsburg, N. J., and chairman, Lehigh Valley Chapter, American Society for Steel Treating, was elected a member of the board of managers.

The Electric Furnace Construction Co., Philadelphia, announces it has secured an order from the Sociedad Espanola De Construccion Naval, Madrid, Spain, for a new design of electrically-heated car-type annealing furnace for heat treatment of large steel ingots and forgings. The furnace will be the largest electric furnace in the world for this particular class of work, and the dimensions are 6800 millimeters long x 4750 millimeters wide x 4140 millimeters high, and will

heat a charge of 60 tons of steel to 1700 degrees Fahr. every 24 hours. The Electric Furnace Construction Co. has already supplied the same company with an electrically-heated furnace 36 feet deep x 12 feet outside diameter for heat treatment of gun and large forgings. The heat regulation on both furnaces is entirely automatic in regulation and a predetermined heat of within 5 degrees plus or minus can be secured. Furnaces of this type offer a big field for the power supply companies, as they have a unity power factor and usually are operated continuously.

"Shop Handbook on Alloy Steels" is the title of a very comprehensive booklet on alloy steels recently published by the Joseph T. Ryerson & Son, Chicago. The book is written by G. Van Dyke, manager of the special steel department. Preparation is very complete, each subject being treated in a separate chapter. A number of tables and illustrations are used.

A small handbook on high speed steel has been prepared by the Vanadium-Alloys Steel Co., Latrobe, Pa. Illustrations are shown of all standard sections of tool steel made by the company. Included in the information are sections on heat treatment and grinding of high speed steel.

W. C. Peterson, for the past 12 years in charge of the metallurgical laboratories, heat treating departments and research work, respectively, of the Packard Motor Car Co., Detroit, has resigned to take charge of the metallurgical department of the Atlas Crucible Steel Co. at Dunkirk, N. Y., where he will undertake a similar character of work. He is a member of several committees of various national metallurgical and engineering societies.

The Atlas Crucible Steel Co., with plants at Dunkirk, N. Y., and Welland, Ont., will move its general offices, including general sales, to the Hanna building, Cleveland, the change to become effective April 15. The company has recently extended its facilities and in addition to its regular line of tool steels, it is now producing high quality alloy steels. Frank P. Case is in charge of the sale of tool steels and Harry J. West of alloy steel sales.

"Oil and Gas Burners" is the subject of bulletin No. 223 issued by the W. S. Rockwell Co., New York. It deals with various types of burners used for industrial heating, emphasizing the fact that the real question is not alone one of burner selection but rather the successful conduct of a heat treating operation as measured by the cost of production of a quality product. Contents of the pamphlet are: The real efficiency of a burner, the selection of type and size to suit nature and pressure of fuel and atomizing element, methods of attaching burner plates, prices of different sizes in each type of burner, and a chart showing the comparative cost per million B.t.u. at unit prices.

E. K. Mull, of Jeanette, Pa., has been appointed metallurgist of the Spicer Manufacturing Corp., South Plainfield, N. J.

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EMPLOYMENT SERVICE BUREAU

The employment service bureau is for all members of the Society. If you wish a position, your want ad will be printed at a charge of 50c each insertion in two issues of the Transactions.

This service is also for employers, whether you are members of the Society or not. If you will notify this department of the position you have open, your ad will be published at 50c per insertion in two issues of the Transactions. Fee must accompany copy.

Important Notice.

In addressing answers to advertisements on these pages, a stamped envelop containing your letter should be sent to AMERICAN SOCIETY FOR STEEL TREATING, 4600 Prospect Ave., Cleveland, O. It will be forwarded to the proper destination. It is necessary that letters should contain stamps for forwarding.

POSITIONS OPEN

Assistant superintendent in forge laboratory in large University in Middle West. Applicant must be familiar with modern methods of heat treatment of steel and with forge shop management. Age not over 28 or 30. College training desirable but not required. Position open Sept. 1, 1921. Good opportunity for young man wishing to enter the profession of teaching. Location Illinois. Address PO-11.

Large manufacturing concern desires to get in touch with practical steel treater accustomed to use of pyrometers, gas furnaces and modern equipment,—one who can deliver the goods, efficient and versed in modern methods for production in the way of steel treating. Address PO-9.

POSITION OPEN—for a steel salesman for Illinois and Iowa. Desire man acquainted with trade in Tri-Cities. Man with practical shop and hardening experience preferred. Permanent position to right man with opportunity for advancement. Salary to start $175.00 and bonus. Answer PO-2

POSITION OPEN—Want to get in touch with a few established manufacturers, agents or high calibered district salesmen to sell the best heat resisting alloys obtainable. We are making some changes in an established organization. Answer PO-3

Consulting metallurgical and supply house located in Eastern Pennsylvania will accept representation of leading firms in the manufacture of metallurgical equipment and supplies. Address PO-8

WANTED—In tool and alloy steel research department, 1919-1920 technical graduate, who has specialized in iron and steel metallurgy. Must not be afraid of getting right down to brass tacks in the way of running experimental melting and heat treating furnaces. Duties include wide range of work, and position offers unusual opportunity for future advancement. Address P. O.-7

POSITIONS WANTED

CHEMIST OR METALLURGIST: Four years analytical work, blast furnaces, open hearth and by-products plants. Three years as chemist and metallurgist in charge of large crucible and electric furnace, and heat treating. Best of references. No preference as to location. Address 5-1.

CHEMIST, METALLURGIST, or SALES DEPARTMENT: Served two years as chemist on semi-steel, carbon and alloy steels, also high speed steel. One years experience on electric furnace construction. Familiar with heat treatment of high speed steel as well as carbon and alloy steel. Have also worked on cast high speed steel. No preference as to location. Salary $2400. Address 3-4.

WANTED—Position as sales manager, Gentile, of years of experience in tools, tool and alloy steels with unquestionable references in every respect, including many very desirable accounts, thoroughly acquainted with Middle West trade, capable of organizing and handling either main of district office, open to negotitate. Answer 1-33

WANTED—Position as chemist or metallurgist. Seven years experience in carbon and alloy steels. Thoroughly experienced in laboratory research, testing, and shop problems concerning steel. References. Answer 1-34

WANTED—Position as chief or assistant metallurgist. Graduate of University of Michigan. Five years' experience with largest motor car manufacturing companies. Salary $3600.00 Answer 1-5

WANTED—Position as metallurgist. College training. Qualified to direct chemical laboratories. Thoroughly experienced in modern physical test methods, pyrometers, foundry and plant control. A-1 references. Michigan territory desired. Answer 6-.

WANTED—Metallurgical position. College graduate in metallurgy. 26 years old. Has been employed with large steel concern having control of pyrometers. Has also done metallographic work. Answer 1-7

WANTED—Position as metallurgist. Capable of directing heat treating department and chemical laboratory. 8 years' experience in forging and steel stamping field. Answer 1-18

WANTED—Position as metallurgist in New England territory. Married. College graduate. Extensive experience in analysis and testing carbon and alloy steels in automobile and aircraft plants, also industrial research. Salary $60.00 a week. Answer 1-9.

WANTED—Position as foreman of heat treating plant. 37 years old. Married. Valuable experience. Best references. Detroit territory preferred. Answer 1-10

WANTED—Position in vocational shop training or foreman of production department. Graduate of Univetsity of Missouri. Extensive experience. A-1 references. Missouri or Illinios locality preferred. Answer 1-11

WANTED—Position as foreman of heat treating department. 5 years' in charge of large automobile company's plant. Best of references. Detroit territory preferred. Answer 1-12

WANTED—Position as metallurgist in Chicago or vicinity. Married. 30 years old. 3 years in Chicago Technical College. 6 years' practical experience. Salary $3000.00. Answer 1-14

POSITION WANTED—As metallurgical engineer in technical or executive capacity. Six years experience in the automotive industry with few well known concerns. Experienced in physical and chemical testing, metallography, design of modern heat treating plants and control. Technical graduate. Married Age 29. Answer 1-15

WANTED—Position as steel salesman. Has large trade in New England states who are users of high speed as well as carbon steels. Is thoroughly experienced man and capable of making demonstrations. Trade consists of some of largest machine companies in East. Can furnish best references as to ability as salesman and as to character. Answer 1-16

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